

# Improving Healthcare Through AHRQ's Digital Healthcare Research Program



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# EXECUTIVE SUMMARY

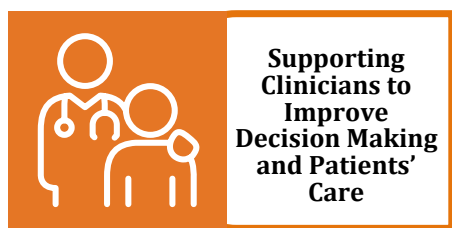
## EXECUTIVE SUMMARY

In early 2020, the burdens of the global COVID-19 pandemic forced society to shut down and disrupted our healthcare system within the span of a few weeks. Fortunately, the application of digital healthcare technologies and digital practices in healthcare—such as artificial intelligence, telemedicine or telehealth, and mobile health—supported healthcare delivery during the pandemic. The evolution of technology and digitization of data now make healthcare delivery available to people everywhere. At the same time, digital healthcare carries great promise to help patients better manage their conditions, coordinate their care, and work with their clinicians for better health. However, these advances are only possible if the people, processes, and technologies (systems) that receive data from disparate data sources are able to make sense of the data and use them to make informed decisions.

The Agency for Healthcare Research and Quality (AHRQ) is the lead Federal agency charged with improving the quality and safety of America’s healthcare system. To support this charge and promote the digital healthcare evolution, AHRQ’s Digital Healthcare Research Program provides foundational research to ensure that digital healthcare systems are designed and implemented in ways that improve quality and safety, while not resulting in excessive burden on physicians and other members of the care team. The Digital Healthcare Research Program funds research to create actionable findings around “what and how digital healthcare technologies work best” for its key stakeholders: patients, clinicians, and health systems working to improve healthcare quality and safety.

In 2020, the program supported 103 research grants and eight contracts that represent a total investment of \$144.5 million. This includes \$37.4 million in grants and contracts to strengthen patient engagement and shared decision making, \$65.3 million to support clinicians’ decision making, and \$41.8 million to improve the delivery of health services at the health systems level.

This Improving Healthcare Through AHRQ’s Digital Healthcare Research Program report outlines the innovative health services research funded by the Digital Healthcare Research Program. The report details the program’s recent research activities and outcomes through research summaries, impact and emerging stories, spotlights, and dissemination activities. Within the research summary section of this report, recently completed research has been categorized by these three research themes:



Following this synthesis, research stories further reflect the impact of AHRQ-funded studies in the researchers' own words. Key information from these impact stories is captured below.

**Table 1: Impact Stories of AHRQ-Funded Research Exemplars**

Organization	Principal Investigator	Impact Story Title	Key Findings and Impact
Denver Health and Hospital Authority	Susan Louise Moore	<u>Engaging Disadvantaged Patients by Using Mobile Technology to Share Patient-Reported Outcomes</u>  Research Investment: \$298,267	Commercial off-the-shelf technology, including mobile phones, can successfully engage disadvantaged patients to collect patient-generated health data and patient-reported outcomes that can be integrated into electronic health records to improve chronic disease care planning during clinical visits.
University of Utah	Andrea Wallace	<u>Low-Cost Screening in the Emergency Department Helps Address Social Determinants of Health</u>  Research Investment: \$299,620	The use of an emergency department referral infrastructure that includes an electronic assessment of patients' social needs (e.g., transportation, food, and housing assistance) can facilitate referrals for those in need and help with monitoring patients post-discharge.
Indiana University-Purdue University at Indianapolis	Christopher Albert Harle	<u>User-Centered Decision Support Tools for Chronic Pain</u>  Research Investment: \$1,954,230	By characterizing common patterns in information availability, information use, and care planning by primary care providers during patient visits for chronic pain, researchers created new electronic health record-based decision support tools to guide clinicians' perceptions and judgments of pain to increase use of guideline-based patient assessment and treatment.
MedStar Health Research Institute	Aaron Zachary Hettinger	<u>Designing Intelligent Systems to Support Cognitive Work of Clinical Providers in Emergency Departments</u>  Research Investment: \$2,491,816	The use of cognitive engineering systems methodology helps to better understand the interactions of the cognitive and workflow processes of frontline emergency medicine providers. Its use also can inform the design of health IT solutions to improve effectiveness of clinical work in high-intensity healthcare environments.

Organization	Principal Investigator	Impact Story Title	Key Findings and Impact
Washington University	Michael Avidan	<u>The Anesthesiology Control Tower: Like Air Traffic Control for Operating Rooms</u> Research Investment: \$299,999	Using algorithms for real-time monitoring during surgery can predict and prevent adverse outcomes, leading to better outcomes for patients.
University of Arizona	Gondy Leroy	<u>Using Natural Language Processing to Improve Autism Spectrum Disorder Research and Care</u> Research Investment: \$292,404	Applying algorithms on free text in electronic health records can identify criteria for autism spectrum disorder, which improves earlier detection and treatment as well as research with large-scale data.
MedStar Health Research Institute	Deliya Wesley and Raj M. Ratwani	<u>User-Friendly Apps to Advance the Use of Standardized Patient- Reported Outcomes</u> Research Investment: \$1,483,876	Using mobile applications developed with standards allows for smoother integration of PRO data into EHRs and will increase the use of PROs for clinical care, patient self-management, and health services research.
University of Wisconsin -Madison	Michelle Anne Chui	<u>Improving Medication Safety With Accurate e-Prescribing Tool</u> Research Investment: \$285,897	Successful implementation of CancelRx, an e-prescribing functionality to electronically communicate medication discontinuation orders between electronic health records and pharmacies, can improve medication safety and reduce adverse drug events.

In 2020, AHRQ funded 23 new research projects to address priority areas, including improving clinical decision making, integration of patient-reported outcomes (PROs) into clinical care, and use of telehealth and telemedicine to improve access to care, an increasingly important focus during public health emergencies. Exciting new research is highlighted in the report, including the goals of the research and anticipated outcomes or future potential application of the work. The following table captures information about the innovative, new digital healthcare research highlighted as emerging research stories within this report.

**Table 2: Emerging Research Stories of AHRQ-Funded Research Exemplars**

Organization	Principal Investigator	Emerging Research Story Title	Significance and Potential Impact
Oregon Health and Science University	Karen Eden, Heidi Nelson	<u>MammoScreen: Using Interoperable Standards Within a Clinical Decision Support Tool to Increase Appropriate Breast Cancer Screening</u> Research Investment: \$1,985,507	Integrating patient-generated breast cancer risk information with patients' electronic health records will enhance decision support for clinicians and patients and improve screening and preventive services for patients at risk.

Organization	Principal Investigator	Emerging Research Story Title	Significance and Potential Impact
University of Wisconsin-Madison	David H. Gustafson, Marie-Louise Mares	<u>The Virtual Smart Assistant: How Voice-Controlled Technology Can Support Self-Management of Healthcare in Older Adults</u>  Research Investment: \$1,987,467	Enhancing an evidence-based electronic health intervention, Elder Tree, with voice-controlled technology can broaden its use, leading to improved overall health and reduced hospital readmission for older adults with multiple chronic conditions.
University of Texas-Austin	Kevin John Bozic, Joel Tsevat	<u>Time for Surgery? Using Patient-Reported Outcomes for Shared Decision Making for Osteoarthritis Patients</u>  Research Investment: \$299,878	Successful validation of a patient-reported outcomes-guided shared decision making tool for patients with osteoarthritis of the knee may lead to widespread scaling and use by musculoskeletal providers and their patients.
Johns Hopkins University	Jeremiah Hinson, Scott Levin	<u>It's Not Just for Sci-Fi: Using Artificial Intelligence to Identify Kidney Disease</u>  Research Investment: \$1,963,619	Successful development and implementation of an artificial intelligence-driven clinical decision support system for detection and treatment of acute kidney injury in the emergency department may improve the quality of kidney care and generate best practice methods to advance the application of artificial intelligence as well as develop a scalable clinical decision support product.
HealthPartners Institute	Elyse Kharbanda, Catherine Benziger	<u>Young at Heart: Improving Hypertension Management in Kids</u>  Research Investment: \$1,995,774	Patient-specific and evidence-based treatment recommendations for identification and management of elevated blood pressure and hypertension in youth, delivered via clinical decision support, may promote adherence to clinical practice guidelines and may improve long-term cardiovascular health in an at-risk population.
University of Washington	Giana Davidson	<u>Improving Care Transitions of Hospitalized Patients With the Pharmacy Integrated Transitions Program</u>  Research Investment: \$2,000,000	Standardizing the hospital-to-skilled nursing facility transition by using a structured handoff between clinical teams along with a pharmacist to monitor patient medications during the transition may improve care coordination and communication, and reduce medication-related issues for patients.
Indiana-Purdue, University at Indianapolis	Titus Schleyer	<u>Creating A Health Information Exchange Application to Provide Fast Access to Patient Data in Emergency Department Settings</u>  Research Investment: \$1,143,378	Integrating health information exchange data directly into electronic health records has the potential to improve delivery of care and patient outcomes, as well as increase clinician satisfaction by providing efficient access to health information exchange data.



In communities across the Nation, telehealth and technologies to support collection of patient-generated health data emerged as a lifeline for care during the COVID-19 pandemic. These rapidly advancing technologies connected patients to healthcare services in ways that were unimaginable pre-pandemic. This past year has expanded and cemented telehealth's role in healthcare delivery in the United States, but challenges still remain. This report spotlights the AHRQ Digital Healthcare Research Program's ongoing research investment on telehealth's potential to support patient care that's effective, safe, affordable, and equitable. Our current research is focusing on how to evolve post-pandemic patient care to ensure the highest quality of care, support changes in payment regulations, reduce the health disparities that are currently present with the delivery of telehealth services, and promote equal access for all.

Lastly, since dissemination of research findings is critical to knowledge transfer and the spread of impactful evidence-based strategies, this report contains a section devoted to the program's dissemination efforts that include national web conferences, research presentations, and publications. Presentations at large national and international conferences allowed researchers to discuss the impact of their work to thousands of attendees, and over 100 published research articles disseminate their research results even further.

We hope that you enjoy reading about many of the AHRQ Digital Healthcare Research Program accomplishments and the significant impact of all of the health services-funded research. Please send any comments or questions to [DigitalHealthcareResearch@ahrq.hhs.gov](mailto:DigitalHealthcareResearch@ahrq.hhs.gov).



# BACKGROUND

## BACKGROUND

### What We Do

The Agency for Healthcare Research and Quality (AHRQ) is the lead Federal agency charged with improving the quality and safety of America’s healthcare system. AHRQ invests in evidence-generating research and translates research findings into practice to achieve the following goals:

1. Keep patients safe and improve their health.
2. Help health professionals improve healthcare quality.
3. Generate data to track, evaluate, and improve the healthcare system.

The AHRQ Digital Healthcare Research Program supports these goals by funding and disseminating **research evidence** about **how the evolving digital healthcare ecosystem can best advance the quality, safety, and effectiveness of healthcare for patients and their families**. The term “digital healthcare” applies to activities involving the transfer of information between patient and provider throughout the entire patient journey as well as the intelligent use of all related data. The program invests in research grants and contracts awarded to researchers working across the country.

The evolution of technology and digitization of data can make care available to people everywhere. Increasingly, digital healthcare supports patients in managing their conditions, coordinating their care, and partnering with their clinicians for better health. The start of the COVID-19 pandemic forced society to shut down, disrupting healthcare access and rapidly changing the way healthcare was provided. While telehealth technologies have long provided access to care for patients in rural and underserved communities, telehealth became a lifeline for care during the pandemic, bolstered by the Centers for Medicare & Medicaid Services, along with private insurers, allowing payment for telehealth visits. Further, mobile health (mHealth) and other technologies that enable patient-generated health data collection and reporting to providers allowed providers to remotely access information on patient’s health status, conditions, and symptoms, allowing patients to remain safely in their homes, and providers to monitor patients remotely. Even before the pandemic, AHRQ has long invested in telehealth research, mHealth to support patients in engagement and decision making in their own care, and how to effectively integrate patient-reported health data into workflow to guide healthcare providers’ decisions related to prevention, diagnosis, treatment, and long-term care.

We were proud to continue funding digital healthcare research during the pandemic to contribute to the evidence base on improving patient-centered care, supporting clinicians and other healthcare professionals in providing health services, and sharing health information across technologies and healthcare environments to leverage data and technology to strengthen health systems.

## About This Report

This report summarizes the research activities and outcomes funded by the AHRQ Digital Healthcare Research Program in 2020. The objective of the report is to support AHRQ stakeholders, including clinicians, health systems, policymakers, researchers, and patients to:

- **Learn** about the goals of research funded by the Digital Healthcare Research Program.
- **Discover** the innovative health technologies developed and tested by AHRQ-funded researchers, including new and emerging research funded in 2020.
- **Understand** how the Digital Healthcare Research Program improves healthcare quality and safety at the patient, provider, and health systems levels.
- **Gain** insight from the spotlighted work that underscores the patient, provider, and healthcare systems focus of every AHRQ-funded research project.
- **Access** knowledge and products disseminated by AHRQ's Digital Healthcare-funded researchers to enhance knowledge transfer and the replication of successful strategies that improve patient safety and healthcare quality.

# RESEARCH SUMMARY

## RESEARCH SUMMARY

### What We Fund

Digital healthcare knowledge and tools can enhance the efforts of patients, clinicians, and health systems working to improve healthcare quality and safety. The AHRQ Digital Healthcare Research Program funds research to create actionable findings on “what and how digital healthcare works best” for these healthcare stakeholders. Through this research, AHRQ generates the groundbreaking knowledge, tools, and data needed to improve health system performance and health outcomes. These products and tools are used by patients, healthcare professionals, and policymakers

to make informed decisions based on the most current evidence available. AHRQ’s digital healthcare initiative is part of the Nation’s strategy for putting quality information technology (IT) to work in healthcare. By making targeted health information available electronically when and where it is needed, digital healthcare can improve the quality of care at the same time it makes healthcare more cost-effective.

*By making health information available electronically when and where it is needed, digital healthcare can improve the quality of care, even as it makes healthcare more cost-effective.*

### In 2020, the AHRQ Digital Healthcare Research Program Proudly:



Supported 103 research grants and eight contracts.



Managed a \$144.5 million investment.



Issued funding in 26 States and the District of Columbia to over 61 distinct institutions.

### In 2020, the AHRQ Digital Healthcare Research Program continued to fund research in response to over 20 past and present funding opportunities.

The AHRQ Digital Healthcare Research Program’s funding opportunities are designed to fund research that fills knowledge gaps and leads to improvements in the design of digital healthcare systems. The program accomplishes this through grant and contract mechanisms that support different types of health services research, including:

*Learn more about the current AHRQ Digital Healthcare Research funding opportunities [here](#).*



- Exploratory and developmental research grants that support research in the early and conceptual stages of development.
- Pilot and feasibility studies.
- Randomized controlled trials and other studies of technology effectiveness.



- Secondary analyses of existing data.
- Dissemination work that scales evidence-based research more broadly.

In addition, AHRQ funds promising new investigators through awards intended to foster their career development in digital healthcare research.

### **In 2020, AHRQ-funded digital healthcare researchers:**

-  Published over 100 research articles in peer-reviewed journals and book chapters.
-  Presented their research at numerous digital healthcare, health services research, medical, and other relevant conferences.

## **What We Found**

Digital healthcare tools can enhance the efforts of patients, clinicians, and health systems working to improve healthcare quality and safety. Read more below on how our funded research impacts patients, clinicians, or the healthcare system as a whole.



# Strengthening Patient Engagement to Improve Care and Shared Decision Making

## Strengthening Patient Engagement to Improve Care and Shared Decision Making

Patient engagement in healthcare leads to improvements in safety, quality, and satisfaction of care. Digital healthcare tools can facilitate patient engagement via the use of patient portals, smartphones, and tracking vitals or symptoms with wearable technology or mobile apps. Digital healthcare also helps patients to participate more actively in their own health self-management, chronic care management, and wellness at various points of interaction with the healthcare system. In 2020, AHRQ Digital Healthcare Research Program invested \$37.4 million in grants and contracts to help patients, families, and health professionals work together as partners in promoting care improvements over the duration of the projects. Read more to learn how this research has strengthened patient engagement to improve care and shared decision making.

**Self-management** support is central to patient-centered care and care coordination in primary care settings. Digital tools can enable better self-management and provide support to people with chronic conditions, including older adults, which enables them to manage their health on a day-to-day basis. This self-management support can help and inspire people to learn more about their conditions and to take an active role in their healthcare.



- Many potentially effective e-health technologies do not achieve widespread adoption by older adults due to a lack of accessible, user-friendly delivery platforms. To address this, [Dr. Judith T. Matthews](#) of the University of Pittsburgh is studying older adults' perceptions of, motivations to use, and patterns of using an adaptive, multiuser health kiosk located in convenient community locations, to see if there are improvements in self-management of chronic disease symptoms.
- [Dr. Susan Louise Moore](#) and a Denver Health and Hospital Authority-based research team studied the use of commercial off-the-shelf (COTS) technologies by low-income, disadvantaged populations to generate high-quality, patient-generated health data and patient-reported outcomes data. The research team assessed the needs and preferences of patients and their primary care providers and found that COTS solutions such as mobile phones and fitness trackers can successfully engage patients to collect health data to better manage their care. These data are actionable for use in chronic disease self-management and care planning and can be integrated into clinical information systems in the future. **(Read the impact story.)**

**Patient engagement** using digital healthcare technology has become commonplace in healthcare through the ubiquitous patient adoption of computers, smartphones, and tablets. Engagement tools have patient and healthcare navigation capabilities, support chronic disease management programs, and connect patients with their care using remote patient monitoring capabilities. Digital tools supporting patient engagement lead to measurable improvements in safety, quality, and satisfaction of care.

- [Dr. Carolyn A. McCarty](#) of Seattle Children’s Hospital studied the use of a tablet-based interactive health assessment (iHA) to conduct personalized, multi-risk screening for youth to inform clinician-delivered health risk behavior counseling. The research team conducted a two-phase mixed-methods study and found that although the iHA contributed to higher rates of clinician counseling for endorsed behaviors, it did not affect self-reported health risk behaviors. Despite these mixed findings, this underscores the need for more research to identify effective risk reduction and patient engagement strategies using technology in adolescent primary care.
- [Dr. Wanda Pratt](#) of the University of Washington and research team investigated the informational needs of hospitalized patients to communicate more effectively with their healthcare teams and engage in their own care planning. The researchers identified several key areas of patient need, which informed the development of three technological prototypes to support inpatients and their care partners in capturing and managing health information, concerns, and questions. The study underscored the need to understand how digital healthcare tools can be used to support patients’ and caregivers’ access to—and engagement with—meaningful information, allowing them to communicate more effectively with their healthcare teams.



# Supporting Clinicians to Improve Decision Making and Patients' Care

## Supporting Clinicians to Improve Decision Making and Patients' Care

AHRQ's Digital Healthcare Research Program funds research to support clinicians and other healthcare professionals in improving their ability to provide optimal health services to their patients. In 2020, a total of \$65.3 million was invested in research projects to support technology-enabled decision making and reducing provider burden. Read more about how our research improves decision making in tandem with improving the experience of health professionals who use electronic health records (EHRs) and other digital healthcare technology.

**Improving clinical decision making** is dependent on clinicians' ability to access the most relevant, accurate, and recent information to make evidence-based decisions regarding a patient's healthcare. Integrating evidence-based clinical decision support (CDS) seamlessly into care helps clinicians by delivering the right information to the correct location and at the right time, so that clinicians can make the best care decisions. When well developed and implemented, CDS uses patient-specific data and relies on evidence-based findings to improve health and lead to the best possible outcomes.



- [Dr. Sheila Maria Gephart](#) and a research-based team at the University of Arizona integrated a previously developed CDS into providers' workflow in neonatal intensive care units to identify necrotizing enterocolitis (NEC) in premature infants. Researchers designed the NEC-Zero intervention to engage families and support team-based care and widespread adoption of evidence-based best practices for NEC prevention. The tool showed high rates of utilization and demonstrated potential for standardized clinical use, which the research team hopes will improve clinical care processes and neonatal outcomes.
- EHRs have the potential to improve clinicians' diagnosis and treatment of obesity by providing tools such as CDS reminders. Yet, much of the CDS development, research, and funding focus has been on adult patient populations. Therefore, [Dr. Mahnoos H. Sharifi](#) and a Yale University-based research team are evaluating different tools within EHRs to assist pediatric care clinicians with providing higher-quality childhood obesity care to slow weight gain in children with obesity.



**Social determinants of health (SDOH)** are conditions in the environment where people are born, live, learn, work, play, and worship that affect a range of health and quality of life risks and outcomes. An integral part of healthcare delivery involves understanding these social and environmental factors of patients' lives outside of the healthcare system. Addressing inequities in these conditions, supported in part through the access and use of contextual SDoH data, can help to eliminate health disparities and to improve individual and population health. However, collection and use of contextual SDoH data may not be feasible in a time-constrained visit. The use of integrated digital health IT tools can support the collection of SDoH data, including the following AHRQ-funded research:

- [Dr. Andrea Wallace](#) and team at the University of Utah evaluated the integration of an electronic social needs screener into the emergency department (ED) workflow. This screener was designed to identify patients in need of referrals to non-emergency, community-based resources such as food, transportation, or housing assistance. The research team partnered with the United Way of Utah's 211 service to facilitate referrals and found that the screener implementation did not pose significant technological, time, or cost barriers. Although only a small portion of patients with reported social needs ultimately received community-based services, the research highlights the feasibility and importance of integrating SDoH into ED discharge planning and its potential to reduce unnecessary ED use. **(Read the impact story.)**



**Improving health technology design to support cognitive work and improve usability** is a focus of AHRQ-funded research aimed at addressing EHR-related provider burden. The following research explored ways to improve technology design and use, including clinical workflow, communication, cognitive load, and user satisfaction to reduce provider burden:

- [Dr. Deborah Jill Cohen](#) and team at the Oregon Health and Science University examined the informational needs of care teams to inform design principles for supporting health IT management and care coordination. The research team conducted a mixed methods study of community health center clinicians and clinical teams to identify a range of informational needs regarding patients' SDoH. Based on these findings, the researchers defined a set of EHR design principles, which was then used to develop an SDoH data collection prototype. Usability testing of the prototype was promising, highlighting its potential to inform clinical decision making when caring for complex patients.



- [Dr. Christopher Harle](#) and research team at Indiana University–Purdue University at Indianapolis developed two user-centered CDS prototypes, Chronic Pain OneSheet and Chronic Pain Treatment Tracker, to support guideline-based clinical decision making for chronic musculoskeletal pain management. The research team conducted a design workshop and usability testing with primary care providers to

characterize information use and decision making patterns and found that information accessibility, organized tables, interactivity, and visual cues were imperative design factors. By characterizing common patterns in information availability, information use, and care planning primary care providers relied on during patient visits for chronic pain, the researchers created new EHR-based decision support tools to guide clinicians' perceptions and judgments of noncancer pain. This led to increased use of guideline-based patient assessment and treatment. **(Read the impact story.)**



- Health IT systems must be designed to support healthcare providers' cognitive work, workflow, and decision making needs, rather than requiring them to adapt their cognitive work and workflow to meet the system's requirements. To address this, [Dr. Aaron Zachary Hettinger](#) of MedStar Health Research Institute performed a cognitive engineering analysis of ED clinicians' cognitive needs and workflows to inform the design of health IT for use in complex healthcare environments. The research team conducted EHR data analyses, focus groups, interviews, and observations to identify gaps and challenges in existing health IT and to evaluate prototype usability in a clinical simulation center. The research team identified gaps and challenges related to existing health IT, as well as strategies to improve the methods for developing and testing before implementation. **(Read the impact story.)**
- Home healthcare (HHC) agencies have been slow to adopt EHRs and mobile technology. Therefore, transition into HHCs can be challenging because of the absence of, or limits to, an electronic information flow between hospitals and home care agencies. [Dr. Paulina Sockolow](#) of Drexel University developed and disseminated a set of IT and EHR design and implementation recommendations for use in HHC transitions. The research team examined nurses' informational needs, decision making, and workflow during HHC admissions, finding that they often lacked the necessary information prior to entering a patient's home and instead relied on prior experience to form plan-of-care decisions. This research highlights the need for standardized and interoperable health IT solutions for use in HHC settings.
- Blood cultures are the only way to diagnose sepsis, a life-threatening bloodstream infection that can affect infants in the pediatric intensive care unit (PICU); however, overuse of blood cultures may result in unnecessary laboratory tests, unnecessary antibiotic use, prolonged hospitalization, and increased healthcare costs. To support clinician's decision making, [Dr. Anping Xie](#) and team at the Johns Hopkins University developed, implemented, and evaluated an EHR-embedded CDS tool to support naturalistic decision making in blood culture utilization among PICU clinicians. The research team examined individual and team cognition and decision making associated with obtaining a blood culture and used those insights to develop the electronic CDS tool iteratively and found that unnecessary blood culture

utilization was reduced. The process and architecture used in the development of the CDS tool may be applied to other conditions commonly seen in the PICU, such as venous thromboembolism and traumatic brain injury, and may potentially be generalizable to other healthcare settings.

- [Dr. Tosha Beth Wetterneck](#) of University of Wisconsin–Madison designed and tested Tandem EHR, a prototype to support the cognitive work, such as information searching, situation assessment, problem identification, and problem solving, of primary care physicians and their teams. Through cognitive task analysis, the research team identified providers' key situation awareness needs, which then informed the design of an EHR prototype. Usability testing of the EHR prototype showed positive results that underscore the need for technology to support the cognitive work of primary care providers and to improve teamwork, provider satisfaction, and quality of patient care.



# Improving the Delivery of Health Services at the Health Systems Level

## Improving the Delivery of Health Services at the Health Systems Level

AHRQ-funded research aims to improve the delivery of health services at the health systems or organizational level; this investment was \$41.8 million over the duration of projects that were ongoing in 2020. The use of machine learning and efforts to share health information across technologies and healthcare environments are key aspects of research projects focused on health systems. Dissemination of successful data strategies and technology to strengthen healthcare delivery are also key.



**Machine learning** is a type of artificial intelligence that programs computers to learn information without human intervention. In machine learning, development of the underlying algorithms relies on computational statistics. Computers are provided data, which they then “learn from.” The data actually “teach” the computer by revealing their complex patterns and underlying algorithms. The larger the sample of data the “machine” is provided, the more precise the machine’s output becomes. Machine

learning and algorithm use in healthcare are becoming more widely used, and AHRQ is funding multiple research projects to understand how they can help patients and clinicians.

- [Dr. Michael Avidan](#) and team at Washington University developed and evaluated an air traffic control-like command center to monitor hospital operating rooms and forecast adverse patient outcomes. The Anesthesiology Control Tower (ACT) used data mining strategies and machine learning algorithms to analyze data from perioperative EHRs and real-time physiological data from the operating suite. The research team found that the ACT algorithms were able to predict postoperative adverse outcomes with a high degree of accuracy, leading to better outcomes for the highest risk patients. **(Read the impact story.)**
- Researchers at the University of Michigan, led by [Dr. Charles Friedman](#), applied learning health system methodology with the goal of advancing individualized precision prevention (IPP) for Grade A and B USPSTF recommendations. Using realistic patient scenarios, the researchers tested concordance between the IPP algorithm’s ranking of preventive service recommendations and primary care provider rankings of those same services. They found an intermediate level of concordance, suggesting that IPP algorithms can help tailor selection and enactment of preventive services in practice.



- [Dr. Gondy Leroy](#) and team at the University of Arizona developed and evaluated natural language processing (NLP) and machine learning algorithms to identify autism spectrum disorder (ASD) behaviors according to Diagnostic and Statistical Manual of Mental Disorders criteria. The research team created a prototype user interface that reviews and automatically annotates the often-overlooked free-text notes in EHRs with a high degree of precision, revealing that the use of ASD-specific NLP algorithms in clinical practice have the potential to facilitate earlier diagnoses of ASD in children, leading to earlier treatment and support for these individuals. **(Read the impact story.)**
- A Brown University team led by [Dr. Thomas Trikalinos](#) used machine learning technologies, including natural language processing, information retrieval, and text mining methods, to optimize the efficiency of the systematic review process and mitigate the challenges associated with information overload in the literature identification process. The team developed a literature identification process that unifies the query formulation and citation screening steps and uses modern approaches for text encoding to represent the text of the citations in a form that can be used by information retrieval and machine learning algorithms.



**Scaling the use of patient-reported outcomes (PROs) to improve care** is a priority of the AHRQ Digital Healthcare Research Program. PROs can yield insights into health status, function, symptom burden, adherence, health behaviors, and quality of life, since they come directly from the patient. Yet, PRO data are not routinely collected or used in clinical practice for several reasons, including patient and provider usability and lack of integration with EHRs. Recent efforts to advance the use of proven PRO apps include the following AHRQ-funded research:

- [Drs. Deliya Wesley](#) and [Raj. M. Ratwani](#) of MedStar Health Research Institute investigated the functionality and usability of user-friendly electronic applications to collect diverse PRO measures in a standardized manner in a mix of ambulatory care settings. The research team pilot-tested two apps—the PROMIS Reporting and Insight System from Minnesota (PRISM) app (the winner of AHRQ’s 2018 Step Up App Challenge) and an existing PRO data collection app that was modified by incorporating FHIR technical specifications. The findings identified various factors crucial for the successful adoption, potential scaling, and sustained use of such technologies, including the availability of technical



assistance, additional staffing, and supportive institutional policies. **(Read the impact story.)**

**Electronic health information exchange (HIE)** allows physicians, nurses, pharmacists, and other healthcare providers to appropriately access and securely share a patient’s vital medical information electronically—improving the speed, quality, safety, and cost of care. While HIE is

common, its utility is often hampered by the lack of seamless integration into clinical workflow. AHRQ-funded research is identifying the best ways for providers to fully leverage this technology, including the following study:

- [Dr. Brian Dixon](#) of Indiana University–Purdue University at Indianapolis investigated the use and impact of a HIE system among multiple hospital EDs across Indiana. The HIE, which linked provider access data to clinical data about each ED encounter, was used more frequently once a single sign-on (SSO) feature was implemented, highlighting the importance of integrating the HIE into clinical workflows seamlessly. The findings suggest that future research should examine the effect of standardized HIE training for providers and whether additional functionalities such as customized user profiles can increase HIE use and impact.

**Medication safety** has improved significantly over the last two decades with the use of digital health and other health IT tools. While errors may happen at all stages of the medication process, different tools have been developed to support the prescribing process (e.g., computerized prescribing with decision support), the dispensing process (e.g., barcoding or automated dispensing and unit-dose systems), and the administration process (e.g., electronic medication administration records and smart pumps). Digital healthcare tools can reduce medication dosing errors and preventable adverse events such as drug-drug and drug-allergy interaction rates by increasing documentation quality and transparency, enhancing accuracy and correctness within the medication process, and supporting information exchange by interlinking different stages of the medication process.

- [Dr. Joanna Abraham](#) and team at the University of Illinois at Chicago examined the use of a void alert tool (VAT), an error alert function embedded in a hospital inpatient computerized provider order entry (CPOE) system, to identify medication ordering errors. The research team found that all reported ordering errors were due to a combination of associated risk factors, including communication gaps in the patient care team and workflow interruptions. Although no adverse drug events occurred, the findings point to the need for multifaceted strategies such as VAT in CPOE systems; this will likely ensure medication ordering safety and prevent potential harm to patients.
- While the implementation and enhancement of digital healthcare tools has made significant strides in addressing medication safety, patients taking prescription medication still experience adverse drug events, with miscommunication in medication discontinuation playing a critical role. [Dr. Michelle Anne Chui](#) and a University of Wisconsin–Madison-based team evaluated the use of CancelRx, an e-prescribing tool to communicate medication discontinuation orders between EHRs and pharmacies. The research team conducted an interrupted time series analysis with outpatient clinics and community pharmacies, finding an immediate and significant increase in successful medication cancellations. Through interviews and observations with pharmacists and clinic staff, the need for a standardized workflow emerged, highlighting the utility of CancelRx to streamline the medication cancellation process, improve medication safety, and reduce potential adverse drug events. **(Read the impact story.)**

## **How AHRQ-Funded Work Impacts Healthcare: Read the Impact Stories**

AHRQ-funded research generates findings that aim to make a tangible difference in patients' health and engage them in their care. This research also examines clinicians' experience and effectiveness providing care and treatment, as well as the overall effectiveness and quality of services delivered through the health system. Told in researchers' own words, the stories below demonstrate the impact of AHRQ-funded research projects.



# Engaging Disadvantaged Patients by Using Mobile Technology to Share Patient Reported Outcomes

Commercial off-the-shelf technology, including mobile phones, can successfully engage disadvantaged patients to collect patient-generated health data and patient-reported outcomes that can be integrated into electronic health records to improve chronic disease care planning during clinical visits.



## PRINCIPAL INVESTIGATOR:

**Susan L. Moore,**  
PhD, MSPH

## ORGANIZATION:

**Denver Health and  
Hospital Authority**

## RESEARCH

### PROJECT PROFILE:

[Engaging  
Disadvantaged  
Patients in Sharing  
Patient-Generated  
Health Data and  
Patient-Reported  
Outcomes Through  
Health Information  
Technology](#)

### FUNDING AMOUNT:

**\$298,267**

## Reducing gaps in care with smartphones

One of the fastest growing areas in healthcare—mobile and digital health—is transforming the way healthcare is delivered. Populations with higher health disparities and lower access to care usually have a higher burden of chronic diseases and worse outcomes due to fewer resources. And while there are effective tools to manage and track chronic conditions, there is a common misconception that disadvantaged populations are too tech illiterate, disinterested, or generally not comfortable enough with mobile applications to use them for healthcare. Dr. Susan Moore and a Denver Health-based research team recognized this misjudgment, noting “it is essential that we do not leave certain patients behind as we advance in the mobile and digital health field.” They sought to explore the suitability of solutions that currently exist in the marketplace and can potentially be used by all patients. Reducing the disparity gap in mobile and digital applications’ use will give minority and other medically underserved groups greater self-advocacy and better quality of care.

## Accessible for all

Dr. Moore and the research team demonstrated that it is possible to use commercial off-the-shelf (COTS) technology to collect information about a person’s health, which can then be shared with their provider to help inform care delivery, care management, and shared decision making around chronic disease management.

The team assessed the needs of disadvantaged patients

through focus groups with 55 patients and showed the feasibility of using COTS technology in a randomized controlled trial with 300 patients using a patient-centered weight management intervention. They then developed a data model, terminology map, and set of Fast Healthcare Interoperability Resources (FHIR)<sup>®</sup>

to facilitate future data integration into providers’ clinical information systems. The goal of this research was to take existing and accessible technologies that are available to traditionally disadvantaged populations to demonstrate that patients could input and share information seamlessly in a structured fashion for providers to access.

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“The value that comes from digital health solutions is and can be for everyone. Implementation is feasible, we can and we must do this for the whole population.”  
—Dr. Moore

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### **Trusting providers and engaging with tech**

Study findings revealed that patients trusted providers to recommend technology that can track their personal health data. Providers preferred to receive a summary of a patient's collected data before a visit instead of receiving an information stream over time. Patient engagement increased overall at the end of the study. Dr. Moore and the research team found that COTS technology can be used to engage disadvantaged populations and believe this can help make strides to improve chronic disease management.



# Low-Cost Screening in the Emergency Department Helps Address Social Determinants of Health

The use of an emergency department referral infrastructure that includes an electronic assessment of patients' social needs (e.g., transportation, food, and housing assistance) can facilitate referrals for those in need and help with monitoring patients post-discharge.



**PRINCIPAL  
INVESTIGATOR:**  
**Andrea Wallace, Ph.D.**

**ORGANIZATION:**  
**University of Utah**

**RESEARCH  
PROJECT PROFILE:**  
[From Emergency  
to Community:  
Implementing a Social  
Needs Assessment and  
Referral Infrastructure  
using Health  
Information Technology](#)

**FUNDING AMOUNT:**  
**\$299,620**

## People's life circumstances affect their health and quality of life

Social determinants of health (SDoH), such as a patient's education, income level, and environment, have a major impact on health outcomes, especially for the most vulnerable populations. Addressing inequities in SDoH can help eliminate health disparities, can improve individual and population health, and should be considered when providing treatment and care. However, questions remain about the best way to collect these data during visits and—more importantly—how to screen and address for social needs during appointments with patients.

Emergency departments (EDs) are currently the only locations within the United States' healthcare system where patients cannot be turned away due to an inability to pay. Consequently, many low-income and uninsured patients are seen in EDs, making them optimal settings for social needs screening. Providers have expressed concerns about how best to integrate this screening into clinical care. Many providers have also found that they do not fully understand the impact of social needs on their patients and how to connect patients to needed nonclinical resources. To address these challenges, Dr. Andrea Wallace decided to study how to develop an effective, sustainable method for integrating both social needs assessment and referrals into routine ED care delivery.



*As a clinical nurse specialist, I focused on chronic illness management in primary care, but I saw a lot of patients with various social determinants of health. I became acutely aware that we can only do so much in our clinical settings. What happens after people go home, or wherever they're going, is what determines their health outcomes. I could put people on the most perfect medication regimen, but it does not matter if they can't integrate taking medications into the context of their lives. I was very passionate about health disparities early on and was introduced to how factors such as health literacy, race, ethnicity, language, geography, and social connectedness affect how different populations access care." —Dr. Wallace*



## Developing and integrating a social needs screener into ED workflow

Dr. Wallace and the University of Utah-based research team, which includes community partners, developed a 10-item electronic social needs screener, using low-cost technology that was integrated into the ED workflow. Patients who indicated that they had unmet needs and who wished to receive assistance were directly referred to the United Way of Utah's 211 service by ED registration staff. This 211 service provides a free, comprehensive list of contact information for local resource providers who address common social needs (e.g., transportation, financial advice, food and housing assistance, etc.). Trained specialists staff this phone line 24 hours per day, 7 days a week and have access to an information pool of over 10,000 services in Utah and the surrounding States.

By putting a standardized process in place for all ED patients, the team wanted to address any stigma involved with the screening, as well as take out the “guess work” of who needed to be screened. The team found that patients were more comfortable when they knew all patients were being asked questions for the purpose of service referrals, rather than perceiving that they were identified for screening because of how they look, their race, or their insurance status. Following the social needs screening, while also tapping into the multiple resources available through the United Way's 211 service, the ED staff has been able to facilitate referrals to appropriate services for a larger number of patients.

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“ Our 211 specialist spoke with a 64-year-old man who mentioned that his health has been getting better but needed information on how to apply for food stamps. Our specialist was able to connect him with *Comunidades Unidas*, to have someone assist him with filling out an application. After 2 weeks, our specialist checked in with the gentleman, and he will be receiving food stamp benefits each month. He mentioned that he doesn't need any other resources and will follow up with *Comunidades Unidas* for additional help.”  
—Staff Testimonial

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## Making an impact on patients' lives

From the screener, the team found that there are four primary drivers—food, housing, utilities, and household items—as to why patients wanted referrals. The 211 specialists contacted these patients at least twice to coordinate referrals, but ultimately it was up to the patient to engage with the specialist and access the referrals. Although only a small subset of patients with reported social needs received community-based services, the team was successful in identifying and addressing these patients' social needs.

Dr. Wallace and the team demonstrated that existing, low-cost, and readily available technology can integrate social needs screening successfully into ED discharge processes. The technology also makes direct referral to expert community resource specialists who are part of a nationwide system. The team also successfully integrated the social needs screening and referrals as part of symptom monitoring after COVID-19 testing via an electronic health record's patient portal, showing that the screening has been easily adopted into COVID-19 testing. Finally, this approach has become a cost-effective way for the team to better understand and address all patients' social needs and health disparities.



# User-Centered Decision Support Tools for Chronic Pain

By characterizing common patterns in information availability, information use, and care planning by primary care providers during patient visits for chronic pain, researchers created new electronic health record-based decision support tools to guide clinicians' perceptions and judgments of pain to increase use of guideline-based patient assessment and treatment.



## PRINCIPAL INVESTIGATOR:

**Christopher Harle, Ph.D.**

## ORGANIZATION:

**Indiana University-Purdue University at Indianapolis**

## RESEARCH

### PROJECT PROFILE:

[Designing User-Centered Decision Support Tools for Chronic Pain in Primary Care](#)

### FUNDING AMOUNT:

**\$1,954,230**

## Caring for and treating complex chronic conditions

Taking care of patients who have complex chronic conditions is best facilitated when a clinician has access to their entire clinical history. A holistic approach is important to understand the best treatment plan for the patient, whether it involves prescribing opioids or other options, based on previous medical history.

Electronic health records (EHRs) often have less-than-ideal navigation to access relevant patient data, and finding these data may be challenging as a clinician gets up to speed during a brief clinic visit. Because opioid misuse is a public health crisis, clinicians are eager for guidance to navigate appropriate treatment options for patients with chronic conditions dealing with pain. With a public health policy and information science background, Dr. Christopher Harle was interested in how to use computers and technology to help clinicians take care of patients with complex, and often painful, conditions.

## Centralized data for easy access

Using qualitative methods, such as interviewing clinicians and reviewing patient medical records, Dr. Harle and the research team at Indiana University and The Regenstrief Institute in Indianapolis wanted to understand how patient information could be best displayed in EHRs to support clinicians in providing the best treatment options for these complex patients. Ultimately, this work led to designing a simplified EHR interface that focused on bringing patient information together in an accessible way for clinicians. Two user-centered prototype decision support tools were created. The first tool—the Chronic Pain OneSheet—was designed to provide accessible data in an EHR for gathering key clinical information. The second tool—the Chronic Pain Treatment Tracker—is used to track treatment and outcomes for patients with chronic pain.

*“What we designed is meant to bring information together in a single place for a primary care clinician to get a holistic picture of their patients and ultimately lead them to choose the right treatment plan.” —Dr. Harle*

## **User-centered design**

Dr. Harle and the team found that user-centered design research was foundational in the development of usable and useful EHR interfaces, such as Chronic Pain OneSheet and Chronic Pain Treatment Tracker. The design of the prototypes captured the distinctive nature of patterns in accessing patient data by characterizing common patterns in information availability, information use, and care planning. These designs help clinicians overcome barriers of technologies that are not user friendly for treatment of chronic pain. The user-centered decision support tools allow clinicians to have an overall picture of patients in an easy and accessible way to help treat a patient with chronic pain.



# Designing Intelligent Systems to Support Cognitive Work of Clinical Providers in Emergency Departments

The use of cognitive engineering systems methodology helps to better understand the interactions of the cognitive and workflow processes of frontline emergency medicine providers. Its use also can inform the design of health IT solutions to improve effectiveness of clinical work in high-intensity healthcare environments.



## PRINCIPAL INVESTIGATOR:

Aaron Zachary  
Hettinger, M.D.

## ORGANIZATION: MedStar National Center for Human Factors in Healthcare

## RESEARCH PROJECT PROFILE: [Cognitive Engineering for Complex Decision Making & Problem Solving in Acute Care](#)

## FUNDING AMOUNT: \$2,491,816

### Emergency departments are complex environments with a high potential for error

Emergency departments (EDs) in hospitals are complex environments and home to some of the most challenging cognitive work conditions for providers: high risk, time pressure, and uncertainty. These environments always have many people moving around and working within time-sensitive and demanding situations. With multiple physicians, advance practice providers, nurses, and other staff attempting to coordinate and provide appropriate care quickly, there is a greater risk for errors, inefficiencies, and suboptimal workflow.

As complexity increases and technology advances, the value of “intelligent” design of health information technology (IT) to better support the work of emergency medicine (EM) providers is more apparent. An improved understanding of how to effectively integrate systems into the workflow of EM providers and nonclinical staff is critical to fully utilize the potential of technology, while also keeping patients safe. Health IT systems should support providers’ cognitive work, workflow, and decision making needs. In contrast, when providers find themselves adapting their cognitive work and workflow to meet the system’s requirements, mistakes and errors in patient care occur.

“ I need to be able to quickly assess what’s going on at any time. If the cognitive tasks aren’t supported by the workflow and the health IT systems, then there’s going to either be misses or delays in care because we’re spending so much time trying to access information. But if there can be [the necessary well-placed information in a] color-coded dashboard, I can quickly say, ‘These are my three patients that are ready for me to make a decision’ and I can quickly get them discharged home or admitted to the hospital or see them right away. With proper workflow and systems, these tasks can be accomplished in a matter of seconds, instead of [the provider] accessing each individual chart on 30 patients that could take 30 minutes alone. And if [the proper data is] up on the board, I can see whose status is changing without having to dive into each individual chart, which is crucial if you’re trying to care for this many patients at the same time.”  
—Dr. Hettinger

## Understanding cognitive needs of ED providers to improve workflow and health IT systems design

To address these issues, Dr. Aaron (Zach) Hettinger and team from the MedStar Health Research Institute, in association with the University at Buffalo-State University of New York and other collaborators, used cognitive systems engineering (CSE) approaches to understand and support complex cognition and work activities in the ED. They also developed models and solutions to some of the biggest challenges in practicing medicine in this complex environment. They knew the ED could benefit from decision aids, visualizations, and other supportive tools and approached the addition of these tools from the perspective of joint cognitive systems, distributed across people, roles, and time.

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“ *The workload monitoring tool was born out of the standard approach of the triage nurse assigning a patient to alternating teams in the ED, which rotates assigning patients between the teams to be equitable. But this [model] doesn’t take into account how sick patients are. Sometimes the first patient that comes in is really sick. The second patient is not that sick. And then the third patient that comes in is really sick and needs a higher level of resources. And so instead of just assigning the patient based on an alternating pattern, the nurse has to have a sense of what’s going on with the teams and their patients, and they might assign the patient to a specific team based on the current workload of each team.*”

—Dr. Hettinger

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The team used a mixed methods approach, including focus groups, interviews, observations, and electronic health record (EHR) data analysis to develop a deep understanding of the cognitive needs of emergency medicine staff, which informed the development of several tools and prototypes. These included a Workload Monitoring Prototype—an embedded workload display tool in the EHR that visually quantifies the individual work associated with a patient while monitoring the distribution of work across providers; a Patient-Centered Display interface, used to incorporate information needs and communication strategies across physicians and nurses to facilitate a holistic view of the patient and communication between these providers; and a Clinical Timeline Chart Review Tool—a timeline-based platform to review the events of an individual’s patient care.

## Supporting providers’ needs to reduce burden and increase patient safety

The research team stresses that successful use of health IT is presenting the right information at the right time visualized in a format that facilitates insight into patterns and management strategies; this clearly-presented information will help providers carry out work effectively and safely. This study’s findings and prototype interfaces represent a step forward in using CSE to support the needs of frontline EM providers with a goal of reducing burden and increasing safety. The ED was an ideal setting for this research because it has some of the most challenging conditions for cognitive work—including high risk, time pressure, and uncertainty—and, therefore, provided findings that can be generalized to other complex healthcare environments.



## The Anesthesiology Control Tower: Like Air Traffic Control for Operating Rooms

Using algorithms for real-time monitoring during surgery can predict and prevent adverse outcomes, leading to better outcomes for patients.



**PRINCIPAL  
INVESTIGATOR:**

**Michael Avidan, M.D.**

**ORGANIZATION:**

**Washington University**

**RESEARCH**

**PROJECT PROFILE:**

[Anesthesiology Control  
Tower: Feedback  
Alerts to Supplement  
Treatment \(ACTFAST\)](#)

**FUNDING AMOUNT:**

**\$299,999**

**Surgery is common, but still risky**

Surgery is a big insult to the human body. A lot can go wrong. In fact, it does. An estimated 10 to 20 percent of patients who undergo major inpatient surgery experience major complications such as heart attacks, unremitting pain, infections, and blood clots in the weeks to months following their procedures; about two percent are dead within 30 days of surgery. Some of this morbidity and mortality may be preventable through early identification of risk factors and better communication to mitigate risks during the surgery. How can we leverage all the data that are collected during surgery—vital signs, heart rate, blood pressure, temperature, fluid administered, drugs given—to predict potential outcomes during surgery in a way that supports decision making?

**Air traffic control concepts can predict high risks  
for healthcare complications and improve decision  
making**

To address this, Dr. Michael Avidan looked to another high-risk industry—aviation—that has significantly increased flying safety by using air traffic control centers on the ground, monitoring all the nearby airplanes and helping them to coordinate their activity, and prioritizing what needs to happen next.

“In the operating room, clinicians are inundated with so much information that they can’t sort it out in real time and separate the wheat from the chaff. And during operations, the patient’s risk isn’t static. It changes with time. So, if you’ve got a lot of bleeding, your risk will go up. If you’ve got a long period with low blood pressure, your risk will go up.” —Dr. Avidan

Dr. Avidan and a team of researchers and computer scientists at Washington University developed and evaluated an air traffic control-like command center for operating rooms (ORs). The *Anesthesiology Control Tower: Feedback Alerts to Supplement Treatments (or ACTFAST)* study applied data mining and machine learning to develop predictive algorithms, helping to predict patients who are at risk for specific complications, including respiratory failure, kidney failure, and death. This study used data from perioperative electronic health records and real-time physiological data that included patient demographic characteristics, comorbid conditions, preoperative vital signs, selected preoperative laboratory values,



intraoperative time series, and selected intraoperative medications. Expert clinicians outside of the OR used Anesthesiology Control Tower (ACT) software to monitor the real-time status of all ORs in the operating suite, where detected events triggered an alert on a clinical dashboard. If clinicians in the ACT decided the alert was important, they provided real-time decision support to the anesthesia team working “on the ground” in the OR on their personal communication devices, and final decisions regarding clinical care were made by the “ground team.”

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“ In the modern world, we now have tools to try to help clinicians to care better for patients, and we should be leveraging technology to help us in this way. Planes are going to be safer when there are computers on board that help the pilots and air traffic control centers that are on the ground. I think that we should be striving to make the acute care of patients safer, using the same kind of thinking and paradigm.”  
—Dr. Avidan

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### **Integrating ACTFAST into operating rooms improves care**

Machine learning algorithms for predicting postoperative death, acute kidney injury, and acute respiratory failure were successfully developed and validated using a database of approximately 110,000 surgical patients. Algorithms were able to predict postoperative adverse outcomes with a high degree of accuracy. The team found that the ACT improved clinician compliance with standards of care, as well as with surrogate measures of patient outcome, such as blood pressure control, temperature, or glucose control. The ACTFAST technology is now fully integrated into all Washington University School of Medicine’s operating rooms. Importantly, because the clinicians in the ACT regularly communicate with anesthesiologists in the operating room, these anesthesiologists have begun to view these clinicians as valuable collaborators. Such cultural acceptance of the ACT by clinicians in the ORs is necessary for the ACT intervention to have any impact on process measures or patient clinical outcomes.

The success of this AHRQ-funded study provided the foundation for a 5-year NINR-funded R01, the Telemedicine Control Tower for the OR Navigating Information, Care, and Safety (TECTONICS) trial, which will evaluate the impact of the ACT on clinical outcomes of patients post-surgery. This exciting and burgeoning research program would not have been possible without the foundational support for the ACTFAST study by AHRQ.



# Using Natural Language Processing to Improve Autism Spectrum Disorder Research and Care

Applying algorithms on free text in electronic health records can identify criteria for autism spectrum disorder, which improves earlier detection and treatment as well as research with large-scale data.



**PRINCIPAL  
INVESTIGATOR:**  
**Gondy Leroy, Ph.D.**

**ORGANIZATION:**  
**University of Arizona**

**RESEARCH  
PROJECT PROFILE:**  
[Enabling Large-scale  
Research on Autism  
Spectrum Disorders  
Through Automated  
Processing of EHR Using  
Natural Language](#)

**FUNDING AMOUNT:**  
**\$292,404**

## Difficulty of accessing unstructured data for decision making

The use of electronic health records (EHRs) and other digital healthcare tools has generated a large volume of data, but it is often difficult to access and use for decision making. In healthcare, data are critical to providers in diagnosing and making informed treatment decisions. While structured health data, including data coded with a standardized code system such as SNOMED or LOINC, can more readily support analysis and decision making, unstructured data—in the form of free texts and narratives—are not easily extractable for use in care delivery. Natural language processing and other machine learning techniques convert unstructured text into structured, codified content in an automated manner for larger-scale use and for integration with other data.

## How can we use that valuable information in free text notes?

Dr. Gondy Leroy of the University of Arizona decided to focus on autism spectrum disorders (ASDs) to show how extracting and coding information from free text in EHRs can lead to new insights and treatments. While the prevalence of ASD has increased dramatically in the last two decades, the causes are not well understood, with hypotheses ranging from changing diagnostic criteria to environmental factors. With new research focusing on neural, genetic, and environmental causes, there is a need to extract new types of data from patient records.

“The importance of this research is that the earlier you identify ASD, the earlier you can provide treatments and services. If you identify ASD at 5 years old, compared to 3-1/2 years old, it’s a big difference. By catching it earlier, you can start treatment and therapy with that child sooner.” —Dr. Leroy

Much of these data, when they do exist, are contained in free-text notes and are not readily available unless manually extracted. Dr. Leroy and the team sought to create methods and tools for leveraging existing and detailed ASD patient information in EHRs to improve ASD research and, ultimately, to improve earlier diagnosis, treatments, and cures.

## Using natural language processing to improve ASD research

The team developed and evaluated natural language processing algorithms to identify ASD behaviors within free text in EHRs, labeling them with the Diagnostic and Statistical Manual of Mental Disorders (DSM) diagnostic criteria for ASD. In addition, machine learning

algorithms were used to label a child's clinical record as either ASD or not. The researchers then developed a prototype user interface that highlights clinicians' free-text sentences containing ASD DSM criteria. This study addressed a gap in EHR use in mental health, where behaviors that meet DSM criteria are frequently buried in free text. Given that children with ASD demonstrate drastically variable behaviors that qualify for the same DSM criteria, diagnosing these children is complex and may be delayed. The algorithms can be integrated in a user-friendly interface, which can help clinicians with limited expertise diagnose children. This work has the potential to improve earlier diagnosis and treatment of children with ASD and enhance research efforts for ASD. Findings from this research led to a recently awarded \$1.5 million grant from the National Institute of Mental Health to expand the technology to support non-expert clinicians in identifying children at risk for autism spectrum disorder.



# User-Friendly Apps to Advance the Use of Standardized Patient-Reported Outcomes

Using mobile applications developed with standards allows for smoother integration of PRO data into EHRs and will increase the use of PROs for clinical care, patient self-management, and health services research.



**PRINCIPAL INVESTIGATOR:**  
**Deliya Wesley,**  
**Ph.D., M.P.H.**



**PRINCIPAL INVESTIGATOR**  
**Raj Ratwani, Ph.D.**

**ORGANIZATION:**  
**MedStar Health**  
**Research Institute**

**RESEARCH PROJECT PROFILE:**  
[Advancing the Collection and Use of Patient-Reported Outcomes Through Health Information Technology](#)

**FUNDING AMOUNT:**  
**\$1,483,876**

## Getting right to the source: using patient-reported outcomes

Patient-reported outcomes (PROs) provide the critical patient perspective for many aspects of healthcare. Their use facilitates shared decision making between providers and patients in a clinical setting, supports self-management for patients, and informs patient-centered outcomes research within the healthcare field. Despite their importance, PROs are not collected routinely. One promising solution to increasing use of PROs may be via mobile applications (apps) developed with standards, which could allow for smoother integration of that data into electronic health records (EHRs) or other health information technology systems. As the Scientific Director for Health Equity Research at the MedStar Health Research Institute, Dr. Deliya Wesley and colleagues wanted to understand how digital solutions can facilitate PROs integration into practice for clinical use and improve outcomes for all patients.

## Setting the technical architecture

Drs. Wesley and Raj Ratwani and their team created an efficient technical architecture to seamlessly integrate PRO data into EHRs using Fast Healthcare Interoperability Resources (FHIR) standards. This research supported the development of standards for electronic applications that collect PRO measures across health providers and systems. The researchers modified and pilot tested an existing app to collect and integrate standardized PRO physical function data into different EHRs, using the newly developed FHIR standards. The team also pilot tested an app that allows patients to complete a set of person-centered measures to support monitoring of their physical, mental, and social health to continue patient engagement with providers outside of a clinical setting.

## Testing in the real world

Lessons learned in this research include the importance of testing in the “real world” to fully understand

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“ We now have these standards; that means when the apps are collecting [PRO] data, it is all in a standard format, encoded the same way, and can be pushed into different EHRs in real time in the same meaningful way, whether it was app A, app B, or app C.” –Dr. Wesley

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local implementation of apps. The research team found that PROs collected through user-friendly and standardized apps can successfully be integrated into different EHRs using interoperable standards. These research findings show that standardized apps, which collect PRO data, can be successfully adopted across healthcare systems, with the ability to improve systemwide comparisons of health outcomes and population health monitoring.





# Improving Medication Safety with Accurate e-Prescribing Tool

Successful implementation of CancelRx, an e-prescribing functionality to electronically communicate medication discontinuation orders between electronic health records and pharmacies, can improve medication safety and reduce adverse drug events.



## PRINCIPAL INVESTIGATOR:

**Michelle Chui,**  
Pharm.D., Ph.D.

## ORGANIZATION:

**University of Wisconsin-Madison**

## RESEARCH

### PROJECT PROFILE:

[CancelRx: A Health IT Tool to Decrease Medication Discrepancies in the Outpatient Setting](#)

### FUNDING AMOUNT:

**\$285,897**

## Catching medication mishaps at the source

When providers discontinue patients' medication in the electronic health record (EHR), clinic staff must manually notify the prescribing pharmacies. Busy staff often overlook this notification step and, despite being removed from the EHR, medications may remain on a pharmacy's dispensing profile for patients. Dr. Michelle Chui recognized this miscommunication can cause a variety of issues, including confusion by the patient or potential adverse drug events. With a pharmacy background and years of research on reducing medication discrepancies, Dr. Chui explored existing technology that can facilitate communication between providers and pharmacists, yielding positive results.

## Bridging the gap of miscommunication

CancelRx is an e-prescribing tool that electronically communicates medication discontinuation orders between EHRs and pharmacies. The technology allows pharmacists to have the most up-to-date prescription information, ensuring that a patient's medication list in a pharmacist's system is accurate. Through a direct notification, CancelRx prompts a patient's pharmacy when a provider discontinues a patient's prescription. Understanding the pressure pharmacists can feel as the "last line of defense" to detect and identify errors for patient medications, Dr. Chui recognizes the significance this tool has—not only to reduce adverse drug events, but to also ensure medical professionals have access to timely data for their patients.

*“Ultimately, the e-prescribing tool CancelRx helps pharmacists do the job that they want to do, and do it safely and confidently with their patient population.”*  
—Dr. Chui

## Immediate success

Dr. Chui and the University of Wisconsin-Madison-based team found an immediate and significant increase in successful medication cancellations after CancelRx implementation, raising the rate of proper discontinuations from 34 percent to 93 percent. Pharmacists recognized the importance of CancelRx and agreed that the successful implementation of this prescription cancellation functionality can improve medication safety. Dr. Chui feels this tool is a model that can have significant impact in reducing medication discrepancies, enhancing patient safety, and providing a sense of security to prescribing providers and pharmacists on knowing their patients' most up-to-date medication information.



# EMERGING RESEARCH

## EMERGING RESEARCH

### **What's New in 2020? New Emerging and Innovative Funded Research**

The AHRQ Digital Healthcare Research Program continues to identify and generate digital healthcare knowledge and tools that are shareable, standards-based, publicly available, and whole-person oriented. Funded research focuses on how digital healthcare solutions can be designed and implemented to improve patient safety, care, and shared decision making without placing excessive burden on users, including patients, physicians, and other members of care teams. In 2020, AHRQ funded 23 new innovative research projects to address AHRQ priority areas. Research goals and the anticipated outcomes or future application of the exciting newly funded research are highlighted below. For more information on an individual Principal Investigator's research, click on the link below.



# Strengthening Patient Engagement to Improve Care and Shared Decision Making

## Strengthening Patient Engagement to Improve Care and Shared Decision Making - Emerging Research

### Using Technology to Support Patient-Centered, Shared Decision Making in Care and Treatment Decisions

Patient-centered shared decision making refers to the collaborative effort of a healthcare provider, patient, and possibly a caregiver, to reach a healthcare decision that is best for the patient and will help better manage their care. The ideal patient-centered decision considers evidence-based information about available options, the provider's understanding, and the patient's preferences. The following research explores digital healthcare tools for patient-centered, shared decision making:

- [Dr. Jennifer Blumenthal-Barby](#) and research team at the Baylor College of Medicine are studying the use of a customized CDS system to support left ventricular assist device (LVAD) implementation in patients with advanced heart failure. They are updating and integrating a validated, artificial intelligence-based, online risk-prediction and communication tool, the Cardiac Outcomes Risk Assessment (CORA) tool, and the research team's own validated LVAD decision aid, Deciding Together, to create a novel tool called the VADDA-CORA. This new tool will offer patients a better understanding of how treatment options align with their values and personalized risks, along with the functionality to communicate these values to the patient's clinical team.
- [Dr. Karen Beekman Eden](#) and team at the Oregon Health and Science University are studying the integration of MammoScreen, a breast cancer risk assessment and clinical decision aid, into an EHR system as well as its effect on patient-personalized decision support and acceptability in clinical practice. MammoScreen provides evidence-based guidance for patients facing decisions about mammography screening and genetic counseling and is an effective tool for identifying individual-level risk and promoting shared decision making with clinicians. The research team will use Substitutable Medical Applications Reusable Technologies (SMART)<sup>®</sup> on Fast Healthcare Interoperability Resources (FHIR) standards to allow seamless data exchange between the external MammoScreen application with the designated EHR. The study aims to inform the implementation and use of health information technology applications for improving the transfer of new evidence into practice and data interoperability across healthcare settings. **(Read the emerging research story.)**



- [Drs. David H. Gustafson](#) and [Marie-Louise Mares](#) of the University of Wisconsin–Madison are studying the use of voice-controlled technology to augment Elder Tree, an evidence-based, eHealth laptop application that provides tools and resources for older adults with multiple chronic conditions (MCCs) to manage their health. Through user-centered design, Elder Tree will be enhanced by adding voice command and a smart display. The study aims to increase the accessibility and sustainability of healthcare self-management tools for older adults with MCCs with the goal of increasing quality of life, improving overall health, and reducing hospital readmissions. **(Read the emerging research story.)**

## Using Patient-Reported Outcomes to Improve Patient Care

Incorporation of brief, validated PRO measures into clinical care to assess outcomes—such as changes in symptoms, emotional health and well-being, and physical and social functioning—is essential to high-quality healthcare. Most PRO data are collected via pen and paper, which is difficult for patients, providers, and researchers to access and use later. While some EHRs capture structured PROs, clinicians do not routinely collect and integrate this information at the point of care. AHRQ is at the forefront of funding innovative research to collect and use PROs that leverage digital healthcare tools to improve patient care and well-being. This research also provides foundational knowledge on how to scale and spread these successful PRO strategies:



- [Drs. Kevin John Bozic](#) and [Joel Tsevat](#) of the University of Texas–Austin are evaluating the effectiveness of a PRO-informed, shared decision making (SDM) tool that estimates the probability of a successful clinical outcome regarding operative versus non-operative treatment for patients with osteoarthritis (OA) of the knee. The research team will implement and evaluate the SDM tool with different patient populations and EHR systems. By centering patients and enabling them to participate in informed medical decision making, the research aims to strengthen the evidence for and promote the scaling of a PRO-guided SDM tool for OA treatment nationally. **(Read the emerging research story.)**
- [Dr. Robert Samuel Rudin](#) and team at RAND Corporation are adapting a successful mHealth app that tracks patients' self-reported asthma symptoms, and scaling it to primary care settings, where most asthma patients are treated. The app will also incorporate functionality relevant to the COVID-19 pandemic to provide insight into how health systems can identify and recruit high-risk patients for digital home monitoring to reduce utilization of pandemic-related limited emergency and hospital resources.





# Supporting Clinicians to Improve Decision Making and Patients' Care

## Supporting Clinicians to Improve Decision Making and Patients' Care - Emerging Research

### Applying Digital Healthcare Solutions in Acute Settings

Emergency departments (EDs) deliver high-volume patient care in hazardous decision-making environments fraught with excessive cognitive loading and time pressure. Digital healthcare solutions in acute settings, such as CDS and artificial intelligence (AI) can support clinician decisions by exploiting large-scale EHR data to aid prognosis, extract signal from noise, and reduce variability in practice.

- [Drs. Jeremiah S. Hinson](#) and [Scott R. Levin](#) of Johns Hopkins University are investigating the use of AI to provide CDS in the detection of acute kidney injury (AKI) in the ED setting. The research team will develop, pilot-test, and evaluate an AI-driven, EHR-based algorithm to estimate AKI risk and flag patients for CDS at three study sites. Successful development and implementation of this AI-driven CDS system for detection and treatment of acute kidney injury will improve the quality of kidney care and generate best-practice methods to advance the application of artificial intelligence and development of a scalable CDS product. **(Read the emerging research story.)**



### Improving Primary and Preventive Care with Evidence-Based Clinical Decision Support Systems

When well developed and implemented, CDS helps clinicians, patients, and others on the care team by delivering the right information at the right time, so the team can make the best care decisions. CDS can support primary care and tailor preventive care during time-constrained appointments. A snapshot of new AHRQ-funded CDS research focuses on preventive care that includes the following:

- [Dr. Marissa Burgermaster](#) and a team of investigators at the University of Texas–Austin are studying the use of a CDS system to support collaborative diet goal setting for patients with obesity, particularly among populations experiencing health disparities. The research team is enhancing an existing CDS prototype, Diet Goal CDS, into a user-centered, EHR- and workflow-compatible CDS that analyzes diet history data and produces a tailored list of personalized diet goals. The enhanced tool will be evaluated to observe behavior change among patients and providers with the overall aim to reduce obesity in their patient population.



- Building on past projects, evidence, and technology, a multi-institution research team led by [Drs. Patricia Dykes](#) and [Robert J. Lucero](#) of Brigham and Women’s Hospital and University of Florida, respectively, will develop a shareable, standards-based CDS tool for fall prevention. This tool will support primary care practices in their fall risk assessment and prevention care plans. Called the Advancing Fall Assessment and Prevention Patient-Centered Outcomes Research Findings into Diverse Primary Care Practices (ASPIRE) project, the research team will leverage multiple sourced evidence-based decision rules and previous clinical trials to inform the ASPIRE CDS and care plan collaboration tool. The tool will identify shareable community-based fall assessment and prevention CDS resources, available at the point of care, that support interoperable fall prevention CDS logic according to HL7 Clinical Quality Standards. The ASPIRE CDS will be tested and implemented in rural and urban primary care clinics, with the aims of embedding the tool seamlessly into clinical workflows while also scaling and disseminating it broadly for use by primary care providers.
- [Dr. Elyse Kharbanda](#) at HealthPartners Institute and [Dr. Catherine Benziger](#) at Essentia Health are evaluating the effectiveness of a previously developed EHR-linked CDS tool, Peds & TeenBP, on screening and treatment of hypertension and high blood pressure among rural adolescents. The research team aims to advance the standard practice of blood pressure measurement, increase hypertension recognition, and promote guideline-adherent management of hypertension in rural youth. **(Read the emerging research story.)**
- An Emory University research team led by [Dr. Evan William Orenstein](#) will develop a CDS system and test its usability, implementation, and impact on influenza vaccine uptake among children at three hospitals. Frontline staff, pharmacists, family advocates, and other stakeholders will be engaged in user-centered design to inform development of a CDS prototype, which will then be evaluated for vaccine uptake. The team hopes that the findings from this study will serve as a CDS model for other health maintenance interventions in pediatric acute care settings.



# Improving the Delivery of Health Services at the Health Systems Level

## Improving the Delivery of Health Services at the Health Systems Level - Emerging Research

### Facilitating Long-Distance Care, Education, and Monitoring with Telehealth and Telemedicine

Clinicians have used telehealth and telemedicine in rural settings and for hard-to-access specialties for years, but its use became ubiquitous during the COVID-19 pandemic. AHRQ-funded research is evaluating how telehealth can be more seamlessly integrated into clinical care, including the following:

- [Dr. Sunday Clark](#) of the Society for Academic Emergency Medicine is convening a conference on telehealth in emergency medicine to develop a national research agenda supporting telehealth in emergency medicine. The conference will aim to strengthen the collaborative exchange of ideas among stakeholders for prioritizing research agendas and best practices that may lead to improvements in patient outcomes and reduce disparities for patients seeking emergency care.
- [Dr. Daniella Meeker](#) from the University of Southern California is studying the impacts of the COVID-19 pandemic on telehealth utilization, outcomes, and disparities to improve the healthcare system's readiness for future public health emergencies. The research team will use a nationwide information system of telehealth services and insurance claims to explore variations between diagnostic and treatment patterns for telehealth versus in-person outpatient care, as well as the ability of telehealth to fill the gaps in ambulatory care. The research aims to elucidate whether telehealth data may be used as a public health surveillance tool to improve an ambulatory care pandemic response.



### Advancing and Disseminating Successful Digital Health Strategies

AHRQ has long been at the forefront of advancing and disseminating effective tools and strategies to spread knowledge and associated evidence-based interventions on a wider scale, including across healthcare settings and software vendors. The following studies demonstrate AHRQ's commitment to disseminate and scale successful tools and strategies across different healthcare systems and technologies (e.g., different EHRs) and disseminate lessons learned about how to achieve scalability and interoperability.

- [Dr. Deborah Jill Cohen](#) of Oregon Health and Science University is developing an evidence-based practical guide to integrating patient-generated digital health data into EHRs of ambulatory care practices. This work aims to advance the integration and meaningful use of patient-generated digital health data, including collecting these data collaboratively with patients and identifying patterns and red flags for clinical workflows and care planning.
- [Dr. Saira Haque](#) and a team of researchers at RTI International are pilot testing two open-source electronic care (e-care) plan applications for managing patients with chronic kidney disease and at least one additional chronic condition. Both e-care applications—one provider-facing and the other patient-facing—retrieve patient data and related resources from EHRs and other health IT systems for aggregation, analysis, and sharing with other healthcare team members. Both e-care plan applications will be open-source, SMART on FHIR applications in order to advance the use of e-care plans for patients with multiple chronic conditions across different healthcare settings.
- A team of researchers at the MITRE Corporation, led by [Kathy Mikk](#), JD, is developing a prototype infrastructure that enables the automated discovery and retrieval of patient-centered outcomes research (PCOR) findings within repositories maintained by AHRQ's Center for Evidence and Practice Improvement (CEPI). The goal of the CEPI Evidence Discovery and Retrieval (CEDAR) project is to make these evidence repositories more findable, accessible, interoperable, and reusable (FAIR) using technologies such as application programming interfaces (APIs). These technologies allow health information technology developers to design new and exciting ways to make information available where, when, and how stakeholders need it most.
- [Dr. Kit N. Simpson](#) and [Dr. Kathryn L. King](#) are investigating the quality and efficacy of the Medical University of South Carolina's four innovative telehealth programs launched during the COVID-19 pandemic: 1) virtual urgent care screening, 2) remote patient monitoring for COVID-19 positive patients, 3) continuous virtual monitoring to reduce workforce risk and utilization of personal protective equipment, and 4) the transition of outpatient care to telehealth. The research team will evaluate overall patient volumes, service uptake, delivery learning curves, safety and quality indicators over time, and population health outcomes. The goal of this research is to provide evidence needed to evolve patient care post-COVID-19 that will ensure the highest quality of care, support changes in payment regulations, reduce the health disparities currently present with the delivery of telehealth services, and promote equal access for all.
- A team led by [Drs. Alex Spyropoulos](#) and [Thomas G. McGinn](#) of the Feinstein Institute for Medical Research is investigating the integration of a service-oriented architecture (SOA) platform-based CDS system into inpatient and emergency department clinical workflows. The research team will embed two validated clinical prediction rules (CPRs) in two commercial EHRs using a CDS system built on a SOA. The research team hypothesizes that by using CDS implemented with standards and service-oriented architecture, guidelines could be implemented throughout the healthcare system, allowing for faster dissemination and updates when guidelines change. Such an approach could

markedly reduce the cost of developing and maintaining CDS, and potentially increase the uptake of evidence-based research findings into clinical practice.

## Digital Healthcare Strategies to Improve Acute Nursing Care



Nurses are directly involved in almost all aspects of patient care in acute care settings, including bedside and medication management, monitoring and assessing, and performing immediate interventions to reduce risk or prevent medical complications. AHRQ investigates how digital healthcare solutions and other health IT can support the work of nurses to improve quality of care and medication safety.

- [Dr. Carolyn J. Sun](#) of Hunter College is investigating the use of an innovative nursing surveillance tool to monitor bedside shift reporting and hourly rounding. The surveillance tool includes wall-mounted hardware in the patient room with computer vision to provide constant surveillance, a Wi-Fi operated call bell, color-coded call lights, and a companion software supplied via a mobile phone app that integrates all these technologies. The research team will analyze the comprehensive data on BSR, HR, and other nurse interactions at the bedside and their effect on nurse-sensitive patient outcomes such as patient falls, pressure ulcer injuries, and hospital-acquired infections.
- Led by [Dr. Raj M. Ratwani](#), a team of researchers at the MedStar Health Research Institute is investigating the usability and safety hazards associated with electronic medication administration records (eMARs) in acute inpatient settings. The research team will develop a human factors-informed medication administration workflow risk assessment tool that allows healthcare facility leaders and EHR vendors to assess information flow, design, and safety of eMARs systems. The overall study goal is to improve medication administration workflow and reduce medication errors. This has been particularly important during the COVID-19 pandemic, as nurses are managing higher-acuity patients and complex medication treatments, while also limiting exposure to infected patients.

## Digital Healthcare Strategies to Improve Care Coordination and Transitions in Care

Care coordination involves deliberately organizing patient care activities and sharing information among all providers involved with a patient to achieve safer and more effective care. Such coordination includes knowing a patient's needs and preferences in advance of needing care and ensuring that this information leads to safe, appropriate, and effective care for a patient. AHRQ funds research on promising interventions aimed at improving communication and coordination, especially during care transitions. During the transition of care, critical information about a patient's condition and health outcomes needs to be communicated accurately and coordinated between the care teams, the patient, and family to ensure that safe, high-quality care is provided, and care continuity is maintained.

- [Dr. Giana Davidson](#) and team at the University of Washington are evaluating the Pharmacy Integrated Transitions (PIT) program and its effect on medication-related problems and patient and caregiver satisfaction among those transitioning from a hospital to a skilled nursing facility. The research team is comparing the traditional, paper-based Joint Commission discharge process to the PIT program, which involves a structured handoff between clinical teams using teleconferencing and a pharmacist to monitor patient medication in the process. The PIT program aims to deter medication-related issues, improve communication between providers and patients, reduce hospital readmissions, and alleviate patient emotional distress by appropriately addressing medication safety during care transitions. **(Read the emerging research story.)**
- [Dr. Arti D. Desai](#) and team at Seattle Children’s Hospital are investigating the use of a novel cloud-based, multidisciplinary care plan, Cloud Care, for children with medical complexity. Cloud Care stores data about a patient’s care plan based on priorities highlighted by parents and providers. Members of the care team can collaboratively review and edit the care plan in real time. The research team is studying the feasibility and acceptability of Cloud Care with the goals of increasing the utility of care plans to inform care coordination for this vulnerable population of children and to improve patient- and family-centered outcomes.

### Digital Healthcare Solutions to Support Emergency Medicine

Health information systems are rapidly being implemented and optimized in a variety of healthcare environments, including emergency departments. These systems offer promising solutions to challenges related to cost, efficiency, patient safety, and medical errors, but technologies must be implemented in ways that support provider workflow and reduce cognitive burden. The following research highlights AHRQ-funded work on the use of digital healthcare solutions to support improvements in emergency medicine.

- The COVID-19 pandemic has exposed vulnerabilities across the U.S. healthcare system. These include challenges related to prevention, such as containment strategies to prevent spread; preparation, such as ensuring sufficient supplies for testing and personal protective equipment; and response, such as anticipating surge events and ensuring sufficient staffing, space, and supplies. [Drs. David R. Kaufman](#) and [Yalini Senathirajah](#) of SUNY Downstate Medical Center are investigating the data needs, decision-making processes, and clinical workflows of hospitals that have been highly impacted by the COVID-19 pandemic. The research team will employ cognitive engineering frameworks to model information workflow and to inform the development of a set of prototypes, including dashboards, visualizations, and data integration tools. The overall goal is to improve emergency responsiveness to more common emergency preparedness events.
- [Dr. Titus Schleyer](#) of Indiana University–Purdue University at Indianapolis is studying the use of an HIE and EHR integration application, Health Dart, on data access and use in ED settings. Health Dart, using FHIR standards, grants providers access to relevant HIE data based on an initial set of conditions, including chest pain, abdominal pain,

dizziness, back pain, pregnancy, arrhythmia, and dyspnea. The research team is studying clinician acceptance of the Health Dart application, data utilization, and overall impact on clinical outcomes. The study aims to further the use of interoperable technologies nationwide as a strategy to reduce unnecessary diagnostic tests, medical expenses, and provider burden in emergency care. **(Read the emerging research story.)**

## **Innovative AHRQ Funded Work: Read the Emerging Research Stories**

The following stories showcase the emerging digital healthcare research knowledge and tools that are being developed, implemented, evaluated, and shared through the new research funded by AHRQ in 2020. Throughout the stories, AHRQ-funded researchers highlight their novel approaches to solving critical problems facing the healthcare system, filling gaps in knowledge, and addressing the limitations of existing digital healthcare solutions.







# MammoScreen: Using Interoperable Standards Within a Clinical Decision Support Tool to Increase Appropriate Breast Cancer Screening and Prevention

Integrating patient-generated breast cancer risk information with patients' electronic health records will enhance decision support for clinicians and patients and improve screening and preventive services for patients.



**PRINCIPAL INVESTIGATOR:**  
**Karen Eden, Ph.D.**



**PRINCIPAL INVESTIGATOR:**  
**Heidi Nelson, M.D., M.P.H.**

**ORGANIZATION:**  
**Oregon Health and Science University**

**RESEARCH PROJECT PROFILE:**  
[Implementing USPSTF Recommendations for Breast Cancer Screening and Prevention by Integrating Clinical Decision Support Tools with the Electronic Health Record](#)

**FUNDING AMOUNT:**  
**\$1,985,507**

## Data to support decision making: available but not accessible

The U.S. Preventive Services Task Force (USPSTF) recommends three breast cancer screening and preventive services based on evidence of benefits and harms: 1) periodic mammography screening, 2) risk assessment and testing for the BRCA1/2 gene mutations that increase risk for breast cancer, and 3) use of risk-reducing medications for women at increased risk. However, women may not receive these recommended services because risk information may be unavailable, inaccurate or incomplete, or difficult to access in most electronic health record (EHR) systems.

To address this issue, an Oregon Health and Science University-based team, led by Drs. Karen Eden and Heidi Nelson, developed MammoScreen, a web-based application of a clinical decision support tool. Designed for women from 40–74 years old, this tool is used to identify an individual's risk for breast cancer, and then engage the patient in shared decision making with their clinician to guide referrals and consider different screening and prevention decisions. While MammoScreen was well received by both patients and clinicians and provided comprehensive and accurate information, its use hinged on manual data entry into the EHR; this would not be sustainable across large patient populations or health systems.

## Cue SMART on FHIR

To address this issue, Drs. Eden and Nelson approached Dr. William Hersh, a leader in healthcare informatics, to help identify a solution for integration. Dr. Hersh proposed that MammoScreen would be a great application for use with Substitutable Medical Applications, Reusable Technologies (SMART) on Fast Healthcare Interoperability Resources (FHIR) standards to exchange data. Using SMART on FHIR will allow

“The technology challenge in using the decision aid in clinical practice arose because the information that resides in MammoScreen and in the EHR doesn't magically flow between them. This research funding supports getting these two systems to work together, so that the clinician gets integrated information about breast cancer risk from the patient via MammoScreen.” —Dr. Eden.



MammoScreen to integrate directly with the EHR, to provide patient-personalized decision support for both patients and clinicians and, in turn, improve quality of care for appropriate breast cancer screening and prevention.

#### **Two-way communication between MammoScreen and the EHR will support decision making**

With the SMART on FHIR integration, patient data from the EHR will be pulled into the tool, so that women will not have to enter existing data. Women will be able to identify and update any incorrect and outdated information, and corrections will be tracked. The resulting risk category (above average or average risk) and breast symptoms identified with MammoScreen will then be stored in the EHR for clinicians to review to guide appropriate care. Once the integration is complete, the team will evaluate its use among patients and clinicians using mixed methods based on the RE-AIM framework. The team expects that the use of this implementation framework will enhance decision support for clinicians and patients and improve screening and preventive services for patients.

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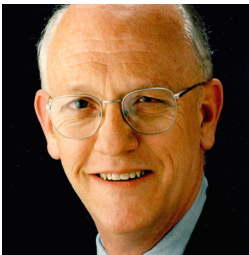
“While SMART on FHIR is new and innovative in healthcare, the idea of moving data back and forth between applications and then displaying them in apps has been around for a decade. We do it on our phones every day. However, this is more challenging in medicine. The data are more complex, the data are more personal. We need to protect them better. SMART on FHIR provides a solution to the problem of supporting communicating between the electronic health record and apps like MammoScreen.” —Dr. Hersh

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# The Virtual Smart Assistant: How Voice-Controlled Technology Can Support Self-Management of Healthcare in Older Adults

Enhancing an evidence-based electronic health intervention, Elder Tree, with voice-controlled technology can broaden its use, leading to improved overall health and reduced hospital readmission for older adults with multiple chronic conditions.



## PRINCIPAL INVESTIGATOR:

**David H. Gustafson,**  
Ph.D.



## PRINCIPAL INVESTIGATOR:

**Marie-Louise Mares,**  
Ph.D.

## ORGANIZATION:

**University of Wisconsin-Madison**

## RESEARCH

### PROJECT PROFILE:

[Using Smart Devices to Implement an Evidence-based eHealth System for Older Adults](#)

## FUNDING AMOUNT:

**\$1,987,467**

## How can we bridge the digital divide for older adults?

As people get older, they need more support for management of their health, especially those who are living with multiple chronic conditions (MCCs), including pain, that can make adherence complex and overwhelming. Although MCCs are usually addressed with a patient's primary care provider (PCP) during visits, time constraints can hinder PCPs' ability to share and explain self-management tools and resources.

As he has aged himself, Dr. Dave Gustafson from the University of Madison–Wisconsin has wanted to understand how technology can support older adults in managing their health. In previous AHRQ-funded [research](#), Drs. Gustafson and Marie-Louise Mares and their team developed an evidence-based electronic health intervention called Elder Tree: a laptop application that provides coping tools, motivation, and social support to help patients with MCCs to better manage their health. They found that, while the tool was successful, the impact was only for those who were high users of primary care (i.e., seemed to have more complex health needs). Moreover, followup conversations with study participants suggested that there was often a large barrier of technology literacy among older adults who weren't connected to other online health and social support systems, and who seemed to need and want Elder Tree the most.



*How can we make it easier for people who are in their later years to benefit from the technologies that are out there? We have been studying this for a number of years now, but we have always used a laptop. Some of the feedback that we've gotten is that using the laptop can be difficult or confusing. You have to log on to a laptop, and you might forget the password and then never sign back in. You might not remember how to scroll down, or if there was something interesting, you can't find it again. Or your hands tremble, and so it's difficult to use a laptop."*

—Dr. Gustafson

## Cue your personal smart assistant

Drs. Gustafson and Mares thought that one way to address this challenge would be to use voice-controlled technology, like a health management "Hey Google" or "Hey Alexa." They are studying whether this technology can broaden and sustain the use of Elder Tree more effectively than the laptop platform.

In addition to audio-activation software, the enhanced Elder Tree system includes a smart display to add a visual component, so a voice command response can be heard and read. The goal of the system enhancement is to increase the impact for older adults with MCCs and chronic pain, in particular. The research team will conduct a three-arm randomized clinical trial comparing treatment as usual to the laptop platform of Elder Tree and to the enhanced “smart system” version of it using a smart device. The team is making a concerted effort to recruit a diverse group of participants to help address racial health inequities. Research has shown that Black Americans may have distrust in the healthcare system and are often undertreated by providers.

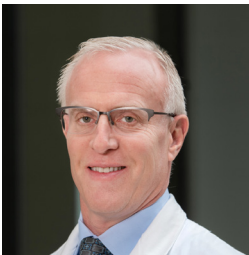
### **Technology to support older adults**

The research team believes this voice-controlled technology may be an effective, accessible, encouraging way to deliver healthcare self-management tools to older adults with MCCs. The central question of this study is whether smart devices can enhance the sustainability of programs such as Elder Tree and, in turn, will significantly increase its impact among older adults. This advancement aims to increase quality of life, improve overall health, and reduce hospital readmission among older patients with MCCs.



# Time for Surgery? Using Patient-Reported Outcomes for Shared Decision Making for Osteoarthritis Patients

Successful validation of a patient-reported outcomes-guided shared decision making tool for patients with osteoarthritis of the knee may lead to widespread scaling and use by musculoskeletal providers and their patients.



**PRINCIPAL INVESTIGATOR:**  
**Kevin Bozic, M.D.**



**PRINCIPAL INVESTIGATOR:**  
**Joel Tsevat, M.D.**

**ORGANIZATION:**  
**University of Texas-Austin**

**RESEARCH PROJECT PROFILE:**  
[Incorporating Patient-Reported Outcomes into Shared Decision Making with Patients with Osteoarthritis of the Hip or Knee](#)

**FUNDING AMOUNT:**  
**\$299,878**

## Knee pain prevalence

Osteoarthritis (OA) of the knee is prevalent among millions of Americans. While it is not a life-threatening condition, it impacts a person's quality of life. OA impairs a person's mobility and comes with an economic impact by affecting people's ability to work and take care of themselves and their families. Total knee replacement (TKR) for severe knee OA is an increasingly popular treatment to alleviate pain and improve function, but about 15-20 percent of patients who have TKR are dissatisfied with the outcome. This adds to the growing concerns around the appropriateness of TKR in some patients. Drs. Kevin Bozic and Joel Tsevat want to better identify patients who are most likely to experience improved health outcomes with this treatment.

## A holistic approach to treating osteoarthritis

Researchers, led by Dr. Bozic at the University of Texas-Austin (UT-Austin), developed a tool to support shared decision making comparing TKR versus non-operative treatment for patients with knee OA by using the patient's information, including pain status, quality of life, mental and physical health, comorbidities, and other characteristics, such as age. The tool is designed to

use data from patient-reported outcome (PRO) scores as well as the patient's preferences and values to inform their decision on whether to choose surgery or not. The research team will conduct a randomized controlled trial of use of the tool at UT Austin, and then integrate and test it in two electronic health record systems and two patient populations at UT Austin and the University of Texas Health Science Center at San Antonio.

## Putting patients in the center of the decision making

This model puts patients at the center of their care and enables them to participate in informed medical

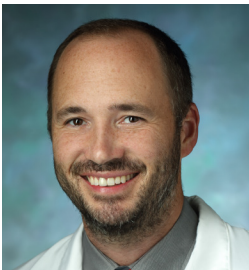
*“When talking about “preference-sensitive” conditions, where preferences matter, I think having tools to inform patients about the pathophysiology of disease and the potential treatment options and possible outcomes, as well as inform the clinical team of the patient’s preferences and values, is really what shared decision making is all about.” –Dr. Bozic*

decision making. This tool provides a specific use case that could potentially increase adoption and use of PROs in routine clinical practice. Drs. Bozic and Tsevat hope the knowledge gained will support scaling and implementing this tool to other musculoskeletal care providers and ensuring this is a feasible and pragmatic tool to implement across the country.



## It's Not Just for Sci-Fi: Using Artificial Intelligence to Identify Kidney Disease

Successful development and implementation of an artificial intelligence-driven clinical decision support system for detection and treatment of acute kidney injury in the emergency department may improve the quality of kidney care and generate best practice methods to advance the application of artificial intelligence as well as develop a scalable CDS product.



### PRINCIPAL INVESTIGATOR:

**Jeremiah Hinson, M.D., Ph.D.**

### ORGANIZATION:

**Johns Hopkins University**

### RESEARCH

#### PROJECT PROFILE:

[Transforming Kidney Care in the Emergency Department Using Artificial Intelligence Driven Clinical Decision Support](#)

### FUNDING AMOUNT:

**\$1,963,619**

### Kidney disease is common but difficult to detect

Providers delivering care in the emergency department (ED) are faced with making high-stakes clinical decisions in a high-volume, time-sensitive, and hectic environment. Acute kidney injury (AKI) is a very common condition for patients presenting in the ED and is associated with adverse clinical outcomes. Unlike conditions such as heart attack, where a provider witnesses a patient wincing in pain, or stroke, where a provider can rapidly measure a patient's strength and assess their speech, it is difficult to identify kidney injury quickly. Detection and assessment of the severity of AKI in the ED setting is limited due to laboratory-based diagnostic criteria and a general lack of syndrome recognition. Diagnosis of AKI currently relies on detection of changes in serum creatinine (sCr) concentration and urine output, both of which may take several days to manifest and identify.

“Oftentimes, the signal that is used to detect kidney injury is delayed. So, no matter what we would do in response to that signal, we don't have a way to know as emergency physicians that this person's going to develop acute kidney injury. There is a protein product that builds up in the blood and it can be measured, but that doesn't happen for days after the initial injury, so we can totally miss it.” —Dr. Hinson

### Complex pattern matching

To address this diagnosing challenge, Drs. Jeremiah Hinson and Scott Levin and a Johns Hopkins University-based research team are betting that artificial intelligence (AI) techniques will be able to extract and analyze relevant electronic health record (EHR) data for AKI detection and treatment in emergency point-of-care clinical decision support (CDS). They are developing an EHR-based algorithm to estimate AKI risk and flag patients at high risk for AKI. This algorithm will then be translated into an AKI-CDS system and pilot-tested among emergency department providers. While it sounds very complicated, Dr. Hinson describes it as pattern matching that is very complex.

## Innovative research that can be scaled and disseminated

Dr. Hinson and team believe this research is highly innovative and will have an impact, as it will generate important knowledge and tools to advance the study and application of AI in the ED; this will result in a CDS product that is scalable via distribution platforms such as AHRQ's CDS Connect. This research has the capacity to improve the quality of kidney care delivered to more than 1 million patients affected by AKI in the United States every year.

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**“** *We have a database with over 300,000 patient encounters from people who have come into the emergency department in the past, some of whom developed AKI. We can use computers and algorithms to really mine all of these data, and look at patterns in patients who developed AKI. We can leverage the information that we've gained over time, to identify patients who are at really high risk, based on other patients in the past, and develop an estimate of how sure we are about that, or what their probability is of developing AKI. All the data come together and they tell a story, but it can be too complex for us to do that pattern matching using a human brain.”* –Dr. Hinson

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## Young at Heart: Improving Hypertension Management in Kids

Patient-specific and evidence-based treatment recommendations for identification and management of elevated blood pressure and hypertension in youth, delivered via clinical decision support, may promote adherence to clinical practice guidelines and may improve long-term cardiovascular health in an at-risk population.



**PRINCIPAL INVESTIGATOR:**  
**Elyse Kharbanda,**  
**M.D., M.P.H.**



**PRINCIPAL INVESTIGATOR:**  
**Catherine Benziger,**  
**M.D.**

**ORGANIZATION:**  
**HealthPartners**  
**Institute**

**RESEARCH PROJECT PROFILE:**  
[Improving Recognition and Management of Hypertension in Youth: Comparing Approaches for Extending Effective CDS for use in a Large Rural Health System](#)

**FUNDING AMOUNT:**  
**\$1,995,774**

Improving Healthcare Through AHRQ's Digital Healthcare Research Program

### Getting youth on a healthy path

Elevated blood pressure (BP) and hypertension (HT) in children are early signs of cardiovascular issues in adulthood, though they often go undiagnosed. Pediatric providers have lots of competing clinical demands in a well-child visit, and may be unfamiliar with pediatric cardiovascular guidelines, missing the opportunity to diagnose and address high BP

and HT in kids. As researchers and doctors who are familiar with the stress of trying to identify and address all conditions in a time-constrained visit, Dr. Elyse Kharbanda and Dr. Catherine Benziger wanted to find a way to support providers with a tool that would identify high BP and HT, and provide recommendations to guide patients and their families on a healthier path.

*“This tool is hopefully helping providers do the right thing. Though it won’t come up frequently for providers, it will not overburden, and ultimately, the tool will help them make the diagnosis and provide education to kids and their families.” –Dr. Benziger*

### A tool to guide the way

In a previous study, Dr. Kharbanda and a HealthPartners Institute-based research team developed, implemented, and evaluated an electronic health record-linked clinical decision support (CDS) tool to provide clinicians with patient-specific recommendations for identification and management of elevated BP and HT in youth, finding that the tool was accepted by providers and, more importantly, improved diagnosis. This time around, the team partnered with Dr. Benziger and the Essentia Institute of Rural Health research team to broadly disseminate the CDS tool, called Peds & TeenBP, in 45 Essentia Health clinics in rural regions of Minnesota, Wisconsin, and North Dakota. Fifteen of the clinics received “high-intensity” training—both online and in-person—for providers to use the tool. The team is studying the effectiveness of the tool in improving recognition and management of BP and HT in kids ages 6–17 years, and the impact training has on providers.

### **Disseminating evidence-based care**

Tools such as Peds & TeenBP are crucial in rural areas where adolescent obesity is high and access to pediatric subspecialty care is limited. Both Dr. Kharbanda and Dr. Benziger predict promising outcomes for the clinics using Peds & TeenBP, “being able to bring the guidelines and best evidence to pediatric and primary care providers will help improve the quality of care that the kids in rural areas receive.” The research team hopes to advance the standard practice of BP measurement, increase HT recognition, and promote BP and HT education among pediatric providers and the kids and families they serve.



# Improving Care Transitions of Hospitalized Patients With the Pharmacy Integrated Transitions Program

Standardizing the hospital-to-skilled nursing facility transition by using a structured handoff between clinical teams along with a pharmacist to monitor patient medications during the transition may improve care coordination and communication, and reduce medication-related problems for patients.



## PRINCIPAL INVESTIGATOR:

**Giana Davidson, M.D., M.P.H.**

## ORGANIZATION:

**University of Washington**

## RESEARCH

### PROJECT PROFILE:

[Preventing Medication-Related Problems in Care Transitions to Skilled Nursing Facilities](#)

### FUNDING:

**\$2,000,000**

## A safe and smooth transition to skilled nursing facilities

The transition of patient care from hospitals to skilled nursing facilities (SNFs) is a complex process, presenting challenges that expose the most vulnerable patients to a high risk of complications, emotional distress, and hospital readmissions. The lack of coordination and effective communication tools between medical professionals at each facility is a significant issue throughout care transitions, which can lead to medication-related problems, and complications that can lead to preventable hospital readmission. As a general surgeon and health services researcher, Dr. Giana Davidson recognized the disconnect in expectations among providers and patients on their care journey, especially for the most vulnerable patients transitioning to SNFs. She wants to improve the care coordination and communication throughout the transition process to ensure patient safety and comfort.

## Following the road to recovery

The Pharmacy Integrated Transitions (PIT) program was developed by Dr. Davidson and team at the University of Washington with the goal to standardize the transition process by using an added

resource of a pharmacy-led integrated transition team who will implement a structured warm handoff and collaborate with the hospital and SNF teams to provide comprehensive support regarding medication management during care transitions. The PIT program integrates a warm handoff tool for the clinical

teams at the hospital and the SNF, including an option for using teleconferencing technology. The program also requires an expanded role for hospital-based pharmacists to reconcile medications at hospital discharge, along with providing teleconference communication to the SNF clinical team and medication monitoring during the transitional period. New funding from the Agency for Healthcare Research and Quality will fund research to test the effectiveness of the PIT program on reducing medication-related problems during the transition period, while also monitoring patient- and caregiver-reported quality of care throughout the process.

“Our hope is that we will see a significant decrease in medication-related problems, and also the downstream consequences of those problems—that people will recover, require less time in SNFs, that they get back to their baseline function, that they will participate more in rehab, that they won’t get readmitted to the hospital... and that patients will be more satisfied with their care.” —Dr. Davidson

### **Measuring inequities in SNF transition processes to improve care**

The PIT program has the potential to provide big impacts to patient care and how we think about care transitional processes. Dr. Davidson is anticipating the program will decrease medication-related problems and improve overall patient safety during the transitional period of care from hospitals to SNFs. The research team will also measure equity within the program's implementation, observing how people from different racial backgrounds, those who do not speak English, and people who are on high-risk medications are managed in the transitional process, thus exposing potential prescribing inequities. The PIT program shows promise to reduce hospital readmissions, lessen patient emotional distress by proactively addressing medication safety, and further reveal areas of improvement to advance healthcare equity within the SNF transition process.



# Creating a Health Information Exchange Application to Provide Fast Access to Patient Data in Emergency Department Settings

Integrating health information exchange (HIE) data directly into electronic health records has the potential to improve delivery of care and patient outcomes, as well as increase clinician satisfaction by providing efficient access to HIE data.



## PRINCIPAL INVESTIGATOR:

Titus Schleyer,  
D.M.D., Ph.D.

## ORGANIZATION:

Indiana University-  
Purdue University  
at Indianapolis

## RESEARCH

### PROJECT PROFILE:

[Improving Healthcare Processes and Outcomes by Directly Integrating Health Information Exchange Data in the Clinical Workflow](#)

## FUNDING AMOUNT:

\$1,143,378

## Finding the right information for timely care

Before the digitization of medical records, data in a patient's record were tied to the institution where the patient received care, which made sharing the patient's health data between different healthcare institutions difficult and time consuming. With the explosion of digital healthcare technologies in the last few decades, in theory, people's health information is more shareable, and therefore accessible. But sometimes the data needed to make critical decisions in urgent care settings are difficult to find. This research is creating a tool so that providers have the important information about a patient's health history, especially in the emergency department (ED) setting, where life and death decisions need to be made quickly.

## In an emergency, time matters

Patient health data are often stored across multiple healthcare systems. A key step to improving healthcare during an acute incident is being able to access information about a patient that may not be documented in their ED medical record. Integrating these data with the clinician's electronic health record (EHR) has the potential to decrease repeated or unnecessary diagnostic tests and to expedite care and treatment in potentially life or death situations.

Currently, HIE functionality is often burdensome to access from a provider standpoint, requiring external navigation outside the ED's EHR system. This disruption of clinical workflow to access HIE data is not conducive to a provider who needs fast and easy access to a patient's medical data. Directly and seamlessly integrating HIE data into the ED's EHR should facilitate data access and use by providers, giving them quick access to relevant data to inform clinical decision making.

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“ED physicians usually don't have much time to make decisions, and there is a sense of urgency to the patient's problems. You really can't spend minutes looking up stuff on the computer when somebody is bleeding to death right next to you. How do we get the most relevant information for the patient in front of emergency medicine providers?”  
—Dr. Schleyer

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### **Timely access to medical information in the ED**

To address this challenge, Dr. Titus Schleyer and team at the Indiana University-Purdue University at Indianapolis are developing and evaluating a novel application called Health Dart that will be implemented and tested in 14 EDs. This application will seamlessly integrate highly relevant information from the HIE directly with the EHR in the ED. The Health Dart application uses the HL7 Fast Healthcare Interoperability Resources (FHIR) standard, which allowed the researchers to develop an application that retrieves data from the HIE and displays it in the ED's EHR, essentially weaving the HIE and EHR environments together. The use of this application has strong potential to improve care. The initial development of Health Dart occurred in a simulated environment where the researchers compared the traditional method of retrieving information from the HIE through a separate (i.e., outside the EHR) web portal to using Health Dart. A provider's search time of relevant information decreased from about 4 minutes to 10 seconds with the number of clicks reduced from 50 to 6. In an emergency, every minute matters, and the researchers believe that this study will show the Health Dart application can improve ED care delivery, patient outcomes, as well as provider efficiency, satisfaction, and HIE use.

# RESEARCH SPOTLIGHT

## Research Spotlight

### Expanding Telehealth During the COVID-19 Pandemic to Keep Patients and Healthcare Providers Safe and Ensure Continuity of Care

In communities across the Nation, telehealth and technologies to support collection of patient-generated health data (PGHD) emerged as a lifeline for care during the COVID-19 pandemic. These rapidly advancing technologies connected patients to healthcare services in ways that may have been unimaginable to many just 18 months ago.

Primary care physicians and advanced practice providers were able to evaluate patients who feared they had developed early symptoms of COVID-19. Pediatricians maintained connections with parents concerned about their children's physical and emotional development. Providers were able to remotely monitor their patients with chronic diseases through mobile devices and other technology that collected PGHD, providing continuity of care during the pandemic, while keeping themselves and their patients safe. Disease experts were able to educate, train, and support healthcare professionals in underserved communities.

Initially, telehealth models of care focused on using video for visits. Yet, as the pandemic unfolded, other models of care that integrated PGHD—defined as health-related data created, recorded, or gathered by or from patients (or family members/other caregivers) to help address a health concern—grew. Providers were motivated to use telemonitoring technologies for symptom monitoring, collecting these data from patients remotely to ensure continuity of care, while keeping patients at home.

While telehealth has been used for decades in rural areas where specialty care is limited, its use was hampered by technology and broadband limitations and, most importantly, lack of reimbursement. In March 2020, the Federal Government expanded Medicare and Medicaid payments for a wider array of virtual office, home, and hospital visits—as well as mental health counseling and preventive health screenings—with most private insurers following. Loosening of



“With the pandemic, when patients are not doing well with their asthma, we don't want them to come in for in-person visits, but they can still be managed remotely. It is important to get them the treatment that they need in a timely manner, because otherwise they might end up in the emergency room, which during a pandemic is the worst place for the patients. The benefit of telemonitoring with patient-generated health data is that it can be done with some relatively simple remote monitoring and a telehealth visit.”

—Dr. Robert Rudin



regulations and funding allowed healthcare organizations to establish or expand telehealth programs quickly. There is now great momentum; telehealth is now considered part of the mainstream of healthcare delivery, and we must ensure that its use is effective, safe, affordable, accessible, and equitable. Telehealth is not just for rural areas anymore. It can be used in schools and correctional facilities, as well as in patients' homes, nursing homes, doctors' offices, and hospitals.

To do so, we must learn how to update technology in rural healthcare organizations, train physicians, advanced practice providers, and other members of the healthcare professional team how to conduct telehealth appointments, and teach patients how to take advantage of virtual appointments when they cannot see a provider in person. Today, in response to these evolving advances in healthcare, AHRQ's Digital Healthcare Research program is supporting initiatives to address vital questions about telehealth's potential to support patient care that's effective, safe, affordable, accessible, and equitable. These activities include research that:



- [Assesses whether asynchronous and synchronous telepsychiatry improve health outcomes in skilled nursing facilities](#)
- [Examines patient clinical concerns and access measures associated with the choice of a telemedicine encounter compared with in-person encounters](#)
- [Adapts an existing mobile application for asthma and COVID-19 symptom monitoring using patient-reported outcomes](#)

While the COVID-19 pandemic accelerated the use of digital healthcare, AHRQ has a long history of supporting research on innovative telehealth technology that improves access to care for patients, most notably supporting and championing the early [Project ECHO work](#)—a program that allows rural primary care clinicians to learn from specialists at urban medical centers by video. Specialists can educate, train, and support rural primary healthcare providers and community health representatives on the best practice treatment protocols for complex diseases over a telehealth network. The quality of care is improved by increasing the skills of the healthcare professionals already based there. Today, Project ECHO is in widespread use in the United States: 250 hubs in 48 States and another 130 hubs around the world. The project now trains clinicians on management of 70 diseases, covering diabetes, HIV, mental and substance use disorders, chronic pain, opioid use disorder, and more.

AHRQ's other foundational research has shown that telehealth has increased patient access to services in such fields as [urgent care for children](#), [psychiatry](#), [speech telerehabilitation](#), [chronic care management](#), and [dermatology](#), while delivering the same quality of care. This research by AHRQ laid the groundwork to support the healthcare system's transition to virtual care during the pandemic.

Despite these known benefits to providers and patients, there are still unanswered questions on the impact and unintended consequences of using these technologies. Even though telehealth has become more mainstream during the

pandemic, challenges persist. It remains inaccessible in areas without broadband internet. Accessibility for people with disabilities and older adults continues to be a challenge in telehealth. And there is still a lot of uncertainty about how using telemedicine more would affect insurers' and hospitals' bottom lines over time, not to mention, patient outcomes. AHRQ wants to find out how telehealth technologies can be integrated into healthcare safely, and to support broader, and smarter, dissemination of these innovations. This research will inform how to evolve post-pandemic patient care to ensure the highest quality of care, support changes in payment regulations, reduce the health disparities that are currently present with the delivery of telehealth services, and promote equal access for all. This newly funded research includes:

- [Assess the validity and timeliness of telehealth information for prospective public health surveillance](#)
- [Evaluate four different telehealth models to provide insight on how to increase capacity in future public health crises.](#)

During the pandemic, the ability to monitor patients remotely while they were at home reduced the need for patients to be seen in person. Many hope that this remote care will continue, especially for those patients with medical conditions who have difficulty accessing in-person care. However, not all practices have the knowledge and resources to successfully implement a remote monitoring care model. Creating value from PGHD requires [investment, commitment, and an understanding of the variables that influence the success of and challenges to PGHD integration](#) that can improve patient outcomes, care coordination, quality, and cost-effectiveness. Telehealth and other technologies that allow for collection and use of PGHD are already redefining how care will be delivered in the future. Millions of Americans have learned to use these new technologies during the COVID-19 pandemic with several studies reflecting early indications of both successful PGHD collection and integration and patient satisfaction. It is critical that policymakers, health systems professionals, and patients and caregivers understand not only the benefits of telehealth and telemonitoring via PGHD, but also the enormous impacts that may come from their expansion. We firmly believe that these technologies will become a key tenet of 21st century care, especially post-pandemic. Understanding how best to incorporate virtual technologies holds the possibility of providing continual care as opposed to the episodic care that is our current norm. Our research on telehealth and other new technologies that allow for collection and use of PGHD continues to broaden the research and medical community's understanding of training, mentoring, diagnosis, and treatment opportunities that benefit healthcare providers and consumers alike.



*How do we help our patients either identify and/or manage chronic illness? When somebody isn't coming into the practice, you can't take their blood pressure. During the pandemic, federally qualified health centers that serve more underserved patients in the U.S. received grants to buy and distribute blood pressure cuffs. Then they helped patients use them, so that they could continue diagnosing and manage hypertension. These were patients that were at higher risk of contracting COVID-19 and having more negative effects, so it was important that they could be monitored at home."*

*—Dr. Deborah Cohen*



# RESEARCH DISSEMINATION

## RESEARCH DISSEMINATION

Dissemination of research findings is an important part of the research process, passing on the benefits to other researchers, healthcare providers and systems, vendors, policymakers, patients, and other stakeholders in order to support replication of successful research. This dissemination from the AHRQ Digital Healthcare Research Program is critical to the transfer of successful digital healthcare knowledge, tools, and strategies that improve patient safety, optimize EHR design, reduce provider burden, and engage patients and caregivers. Digital Healthcare Research Program-funded researchers share and disseminate their research findings in several ways that include publishing in peer-reviewed journals, presenting at health- and IT-focused conferences, and during AHRQ web conferences.

### Reaching the Research Community Through Web Conferences

AHRQ convenes [national web conferences](#) to highlight recent developments and disseminate the impact of innovative digital healthcare research. In 2020, the AHRQ Digital Healthcare Research Program convened two conferences.

The June 9, 2020, web conference, [The Role of Telehealth to Increase Access to Care and Improve Healthcare Quality](#) featured the following:

- Dr. Glen Xiong presented study results on the effectiveness of using telehealth for psychiatric services for people with mental illness who live in skilled nursing facilities. The team found that two modalities of virtual psychiatric consultations for these patients—real-time video conferencing, universally known as synchronous telepsychiatry (STP) and video-recorded interviews later sent to a psychiatrist for review and guidance—improved outcomes.
- Dr. Elizabeth D. Ferucci showcased study results where she compared disease symptoms and the quality of care for patients who receive rheumatology care through telemedicine to patients who receive only in-person rheumatology care. The team found that telemedicine and in-person appointments provide comparable care, which is great news when access to care is an issue for patients.
- Dr. Kenneth McConnochie discussed the Health-e-Access (HeA) telemedicine network in Rochester, NY, used to manage childhood illness, highlighting the value of this type of care to the community. In cases where children may need to be seen quickly, use of the HeA telemedicine network allows children to be seen quicker than an in-person visit as well as receive medication and antibiotics faster.

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**IMPACT:** Participants learned how telehealth can increase access to care and improve healthcare quality in real-world settings, and how evidence supports the use of telehealth during public health emergencies.

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The October 14, 2020, web conference, [Applying Advanced Analytics in Clinical Care](#), featured the following research:

- Dr. Alexander Turchin highlighted research that showed inclusion of information from free-text notes into risk-of-death prediction models significantly improves the ability to predict the probability of death. This research reflects the potential for clinicians to incorporate life expectancy into shared decision making about medical interventions.
- Dr. Judith Dexheimer’s research showed that an EHR-integrated machine learning algorithm can aid clinicians in identifying patients with epilepsy who could benefit from surgery. Use of this algorithm has the potential to decrease time from diagnosis to surgical evaluation, with a resulting improvement in quality of life for patients and caregivers, reduction in suffering, and a decrease in treatment cost.
- Dr. Michael Avidan presented work on developing and evaluating an air traffic control-like command center for operating rooms. The research relied on data mining and machine learning to forecast adverse patient outcomes. Dr. Avidan found that these algorithms can predict postoperative adverse outcomes with a high degree of accuracy, leading to better outcomes for the highest-risk patients.



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**IMPACT:** Participants gained knowledge on how machine learning and natural language processing techniques can effectively analyze unstructured data and process information from multiple sources that identify patients who would benefit from treatments or interventions.

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## Disseminating Knowledge and Research Findings at Conferences

AHRQ Digital Healthcare Research Program-funded researchers presented research findings at a variety of digital healthcare, health services research, medical, and other conferences. These included the Annual Symposium for the American Medical Informatics Association (AMIA), AcademyHealth’s Annual Research Meeting, the Human Factors and Ergonomics in Health Care Annual Symposium, the American Telemedicine Association Annual Meeting, the Society of Medical Decision Making, and the Health Information Management Systems Society’s Global Conference and Exhibition.

At the 2020 Virtual AMIA Annual Symposium alone, AHRQ-funded research was highlighted in 12 sessions and demonstrations. Click on the links below in Table 3 to learn more about this research.

**Table 3: AHRQ-Funded Research at the 2020 AMIA Annual Research Symposium**

AHRQ Principal Investigator	Funded	AMIA Session
Fuad Abujarad	<a href="#">Patient-Centered Virtual Multimedia Interactive Informed Consent</a>	Oral Presentation: <a href="#">Patient-Focused Web-Based Health Tool Facilitating Self-Identification and Self-Disclosure of Elder Mistreatment in the Emergency Department Setting</a>
Barry H. Blumenfeld	<a href="#">Clinical Decision Support for Chronic Pain Management</a>	Poster: <a href="#">Multi-Site Development and Implementation of a Patient-Facing, FHIR-based Clinical Decision Support Tool to Support Shared Decision Making for Chronic Pain</a>
Brian Dixon	<a href="#">Exploring the Utilization of and Outcomes from Health Information Exchange in Emergency Settings</a>	Oral Presentation: <a href="#">The Association of Encounter- And Hospital-Level Characteristics with Health Information Exchange in Emergency Department Encounters: A Longitudinal Log File Analysis</a>
Lacey Fabian (PI), Chris Moesel (presenter)	<a href="#">Patient-Centered Outcomes Research Clinical Decision Support (CDS) Connect Maintenance and Update</a>	Workshop: <a href="#">The New Digital Age of Clinical Decision Support Tools: Open-Source and Interoperable Approaches for Health Systems</a>
Christopher Harle	<a href="#">Designing User-Centered Decision Support Tools for Chronic Pain in Primary Care</a>	Panel Presentation: <a href="#">Actionable Opportunities for Improving Opioid Prescribing Through Use of Informatics</a>
Kensaku Kawamoto (PI), Salvador Rodriguez Loya (presenter)	<a href="#">Scalable Decision Support and Shared Decisionmaking for Lung Cancer Screening</a>	AMIA/HL7 FHIR App Competition - <a href="#">Lung Cancer Screening Shared Decision Making App</a>
Evan Orenstein	<a href="#">Improving Influenza Vaccine Uptake in Acute Care Settings</a>	Panel Presentation: <a href="#">Clinical Decision Support for Health Maintenance Interventions in Acute Care Settings: Three Approaches to Promoting Influenza Vaccine</a>
Jerome Osherooff, Steve Bernstein (AHRQ PO)	<a href="#">AHRQ evidence-based Care Transformation Support (ACTS)</a>	Panel Presentation: <a href="#">A Multi-Stakeholder Roadmap for Care Transformation? The AHRQ evidence-based Care Transformation Support (ACTS) Initiative</a>
Wanda Pratt (PI), Shefali Haldar (presenter)	<a href="#">Patients as Safeguards: Understanding the Information Needs of Hospitalized Patients</a>	Oral Presentation: <a href="#">Patient Portals</a>
Mary Reed (PI)/Ilana Graetz (presenter)	<a href="#">Patient Choice of Telemedicine Encounters</a>	Oral Presentation: <a href="#">Informatics Outside the Clinic</a>
Deliya Wesley and Raj. M. Ratwani (co-PIs), Janey Hsaio (AHRQ PO)	<a href="#">Advancing the Collection and Use of Patient-Reported Outcomes Through Health Information Technology</a>	Panel Presentation: <a href="#">Innovative Tech Solutions Making Data More Accessible for Patient-Centered Research</a>
Joshua Vest	<a href="#">Use of Push and Pull Health Information Exchange Technologies by Ambulatory Care Practices and the Impact on Potentially Avoidable Healthcare Utilization</a>	Oral Presentation: <a href="#">End user information needs for a SMART on FHIR-based automated transfer form to support the care of nursing home patients during emergency department visits</a>

## AHRQ-Funded Research Results Noted as Most Relevant, Interesting, or Innovative of the Year

A special event held during the virtual 2020 AMIA Annual Symposium featured the year's most noteworthy publications. This popular Biomedical and Health Informatics Year in Review session is informed by AMIA's 20 Working Groups, plus a special COVID-19 group. These groups identified papers representing the most influential biomedical and health informatics work published over the past year. The session aimed to help biomedical and health informatics professionals stay current with the most "relevant, interesting, or innovative" papers of the year. The session was introduced by Dr. James Cimino of the Informatics Institute at the University of Alabama at Birmingham. Ninety-five papers nominated by the working groups were reviewed, representing 37 peer-reviewed journals and one symposium. Of these, the following three papers presented the results of AHRQ-funded Digital Healthcare Program research.

### Evaluation Working Group

Dr. David Bates's paper in JAMIA, "[The tradeoffs between safety and alert fatigue: Data from a national evaluation of hospital medication-related clinical decision support](#)" was highlighted as the best evaluation paper. The paper described an evaluation of the overall performance of hospitals that used the Computerized Physician Order Entry Evaluation Tool in both 2017 and 2018. The paper also summarized hospitals' performance against fatal orders and nuisance orders. Research findings showed that despite the improvement of overall scores in 2017 and 2018, there was little improvement in fatal order performance, suggesting that hospitals are not targeting the deadliest orders first. Nuisance order performance showed almost no improvement, and some hospitals may be achieving higher scores by over alerting, suggesting that the thresholds for which alerts are fired from are too low.

### Open Source Working Group

The best open source paper highlighted the work of AHRQ's CDS Connect Initiative. "[To Share is Human! Advancing Evidence into Practice Through a National Repository of Interoperable Clinical Decision Support](#)" describes how a national repository of CDS can serve as a public resource for healthcare systems, academic researchers, and informaticists seeking to share and reuse CDS knowledge resources or "artifacts." The paper outlines the history and ongoing success of CDS Connect, which was first launched in 2016 as a public, web-based platform for authoring and sharing CDS knowledge artifacts. Researchers evaluated early use and impact of the platform by collecting user experiences of AHRQ-sponsored and community-led dissemination efforts through quantitative/qualitative analysis of site metrics. Efforts are ongoing to quantify efficiencies gained by healthcare systems that leverage shared, interoperable CDS artifacts, rather than developing similar CDS repeatedly and in isolation.

### People and Organization Issues Working Group

The final AHRQ-funded work highlighted during AMIA's Year in Review session was Dr. Rebecca Schnall's paper, "[Use of the FITT framework to understand patients' experiences using a real-time medication monitoring pill bottle linked to a mobile-based HIV self-management app: A qualitative study.](#)" The paper outlined Dr. Schnall and research team's efforts



to understand patients' experiences using a real-time medication monitoring pill bottle linked to an HIV self-management mobile app. They found that tracking medication adherence and receiving push-notification medication reminders through the electronic pill bottle connected to the app encourages and supports medication adherence for people with HIV. Research findings highlight the importance of considering intended users' circumstances—particularly HIV-related stigma, disclosure of HIV status, and antiretroviral therapy regimens—when designing customizable mobile health technology.

## AHRQ-Funded Researchers Disseminate Findings in High-Impact Journals

In 2020, AHRQ-funded researchers published over 100 research articles in peer-reviewed journals and book chapters, including the following:

### Displaying Patient Photos in Electronic Health Records Reduces Hospital Order Errors

Adding patients' photographs to the banner of EHRs enhanced patient identification and significantly reduced wrong-patient order errors in a hospital emergency department, according to [Dr. Jason Adelman's research](#). The research team evaluated more than 2.5 million nursing, medication, diagnostic, and other orders for about 72,000 hospital patients. They used the rate of retract-and-reorder events as the outcome measure and noted that this rate was 186 per 100,000 orders for patients with no photograph in their EHRs and 133 per 100,000 orders for patients with photographs. Unlike previous interventions that interrupt providers, this solution did not add to providers' time burden or risk of alert fatigue, according to researchers. To read more, access the [article](#) in JAMA Network Open.



### Why do patients choose telemedicine over in-person primary care?

An analysis of over 2 million primary care appointments scheduled after the 2016 rollout of patient self-scheduling of video and phone visits at Kaiser Permanente Northern California showed that patients were more likely to choose telemedicine over an office visit if they were younger, female, or faced logistical challenges, according to an AHRQ-funded study, led by [Dr. Mary Reed](#). These findings suggest that telemedicine has the potential to reach vulnerable patient groups and improve access for patients with transportation, parking, or cost barriers to clinic visits. To read more, access the [article](#) in JAMA Network Open.

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*Additional research results are available by searching the [AHRQ Digital Healthcare Research Publications Database](#), created to disseminate the work of AHRQ-funded research.*

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## Building the evidence base to reduce electronic health record-related clinician burden



In this JAMIA [article](#), Chris Dymek, director of the AHRQ Digital Healthcare Research Program, along with AHRQ Project Officer Janey Hsaio; former AHRQ employee Bryan Kim; and AHRQ-funded grantees Drs. Thomas Payne, Genevieve Melton, and Hardeep Singh share evidence-based informatics approaches, pragmatic next steps, and future research directions to improve three of the highest contributors to EHR burden: documentation, chart review, and inbox

tasks. These approaches leverage speech recognition technologies, natural language processing, artificial intelligence, and redesign of EHR workflow and user interfaces. The authors also offer a perspective on how EHR vendors, healthcare system leaders, and policymakers all play integral roles while sharing responsibility for making evidence-based sociotechnical solutions available and easy to use. This paper was highlighted as a “notable paper” during the AMIA Clinical Research Informatics Summit Year in Review session.

## CLOSING

The AHRQ Digital Healthcare Research Program continues to lead the Nation in health services research focused on how digital healthcare and health IT can positively impact patient care, support clinicians’ work, and improve the delivery of health services at the health systems or organizational level. In 2020, AHRQ-funded research continued to generate innovative tools and findings in such priority areas as improving communication and coordination during care transitions, optimizing EHR and other health technology design to reduce provider burden and improve workflow, supporting the effective use of patient-reported outcomes to improve patient care, and supporting the sustainability of proven telehealth technologies beyond COVID-19.

The AHRQ Digital Healthcare Research Program remains committed to better understanding how technology and digital healthcare can positively affect the quality and safety of healthcare. Visit our website at <https://digital.ahrq.gov/> to learn more about our team, current funding priorities, [funding opportunities](#), and the [findings and impact](#) of the work we fund.

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